THE WRITING ROOM.

THE SMOKING ROOM.

International marine engineering

International Marine Engineering

VOLUME XIII.

JANUARY TO DECEMBER, 1908

PUBLISHED BY

MARINE ENGINEERING

INCORPORATED

17 BATTERY PLACE, NEW YORK, U. S. A.

31 CHRISTOPHER STREET, FINSBURY SQUARE, LONDON, E. C.

INDEX.

NOTE.—Illustrated articles are marked with an (*) asterisk.

ARTICLES.

EDITORIALS

ENGINEERING SPECIALTIES

PARAGRAPHS.

QUERIES AND ANSWERS.

TECHNICAL PUBLICATIONS.

International Marine Engineering

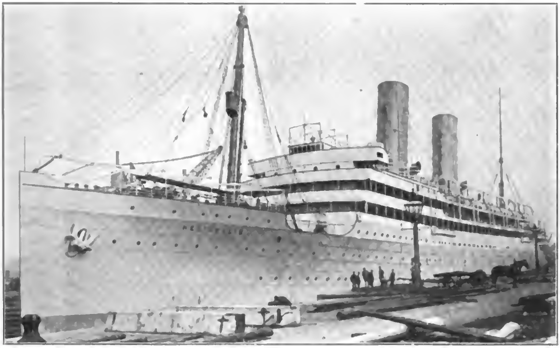
JANUARY, 1908.

NEW EGYPTIAN MAIL TURBINE STEAMSHIP HELIOPOLIS.

BY ALLAN MCPHERSON.

Built by the Fairfield Shipbuilding & Engineering Company, Limited, Glasgow, for the Egyptian Mail Steamship Company, the new turbine steamer *Heliopolis*, which was launched on May 28 last, is notable as being the largest turbine passenger steamer yet built at Fairfield.

The *Heliopolis* has three propellers, driven by three independent Parsons compound steam turbines. In the center of the ship there is one high-pressure turbine, taking steam direct from the boilers. The two low-pressure turbines are mounted on the wing shafts. The astern turbines are also on the wing shafts, inside the low-pressure cylinders. The turbine rotors are of cast steel, each in one piece, and the cylinders are each in two pieces bolted together.



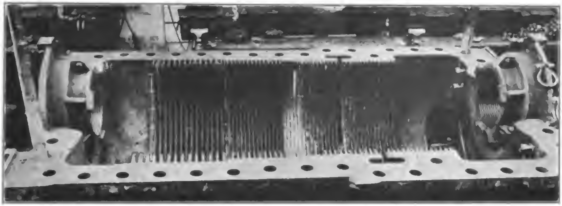
THE HELIOPOLIS IN DRYDOCK AT GLASGOW.

Grooves are cut in the rotors, into which the revolving blades are fixed, and similar grooves are turned on the inner surface of the cylinders, for the stationary blades. The blades are wedged separately into these grooves and are then bound together with brass wire of square section, which fits into a slot cut in the front edge of each blade near the top. This brass wire is laced to the blades with fine copper wire, and then soldered. The turbine blades are of rolled brass. Their length increases from the high-pressure end to the last rows, where the steam passes to the condensers. There are about a million blades in these turbines.

Our illustration of the turbine rotor gives an elevation of the blading arrangement, and, though this is a low-pressure rotor, the principle is exactly the same throughout. In the turbine, the total steam expansion is subdivided into a number of steps. The expansion of steam at any one stage is typical of its working throughout the turbine. Each stage consists of a ring of stationary blades, which gives direction and velocity to the steam, and a ring of moving blades that immediately converts the energy of velocity into useful torque. The total torque on the shaft is due to the impulse of steam entering the moving blades, and to reaction as it leaves them, this process being repeated throughout the turbine.

The turbines exhaust direct into two steel plate condensers, fitted with solid drawn brass tubes, and placed alongside the low-pressure turbines. The cooling water for condensing the exhaust steam is circulated through the condensers by four large centrifugal pumps, two for each condenser, and the condensed steam is withdrawn from the condensers by two single-acting twin air pumps.

The engine room is fully equipped with the most modern appliances, which include three large electric light engines and dynamos, three Hall's CO_2 refrigerating machines, pumps for supplying hot and cold salt water to the baths, also pumps for sanitary purposes, washing decks, for extinguishing fire and for fresh water for passengers' use. There are also bilge and ballast pumps, and these can, in the event of an accident to the

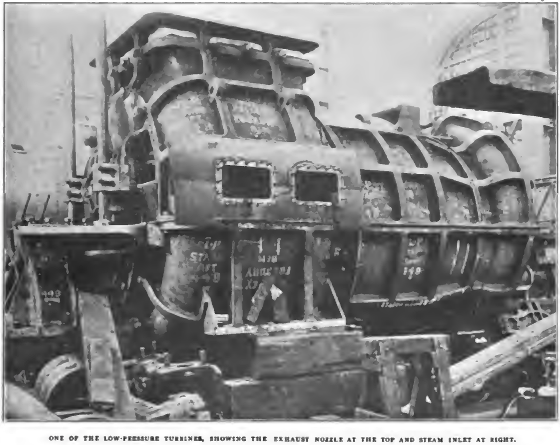


INSIDE VIEW OF THE LOWER HALF OF THE CASING FOR A HIGH-PRESSURE TURBINE, STEAMSHIP HELIOPOLIS.

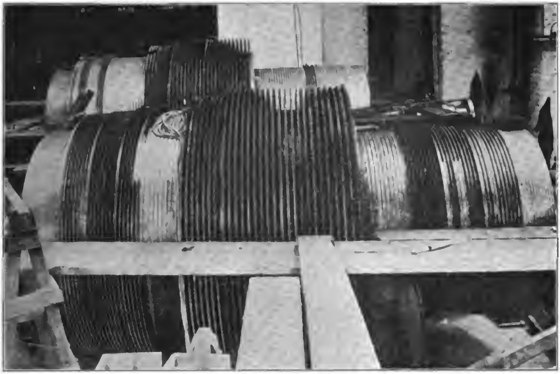
ship, be supplemented by the large circulating pumps, to discharge water from the vessel, the total capacity of these pumps being equal to fully 2,000 tons per hour. In the engine room there are also arranged four large main and auxiliary feed pumps of G. & J. Weir's design. Two gravitation feed filters of List & Munn's patent are fitted, for removing grease and other impurities from the feed water. The distilling plant consists of two large evaporators, together capable of producing from sea water 100 tons of fresh water per day, and two distilling condensers, having a combined output of 12,000 gallons of pure fresh drinking water per day.

The propellers have three blades each, and are made of manganese bronze. They are accurately machined and balanced, and the blades are carefully polished to reduce to a minimum the frictional resistance incidental to the high velocity at which they pass through the water, and which at the tips exceeds 100 miles per hour. The propellers and balanced rudder are clearly shown in our illustration. It is also noticeable that there is no outboard shafting, which arrangement is an advantage to the engineer, as shafting and bearings can be inspected at all times without the necessity of docking the ship.

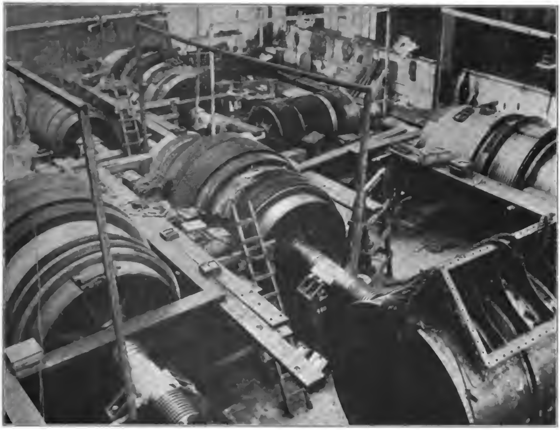
The boiler installation consists of four double and four single-ended steel boilers of the ordinary multitubular type, each working at a pressure of 195 pounds per square inch. These are arranged in two boiler rooms, and the exhaust gases pass into two funnels, which rise to a height of 115 feet above the sea level. The boilers are arranged to work



ONE OF THE LOW-PRESSURE TURBINES, SHOWING THE EXHAUST NOZZLE AT THE TOP AND STEAM INLET AT RIGHT.



LOW-PRESSURE TURBINE ROTORS PARTLY BLADED. THE ASTERN TURBINES ARE AT THE RIGHT END.



GENERAL VIEW OF HIGH-PRESSURE AND LOW-PRESSURE TURBINE ROTORS IN PROCESS OF CONSTRUCTION.

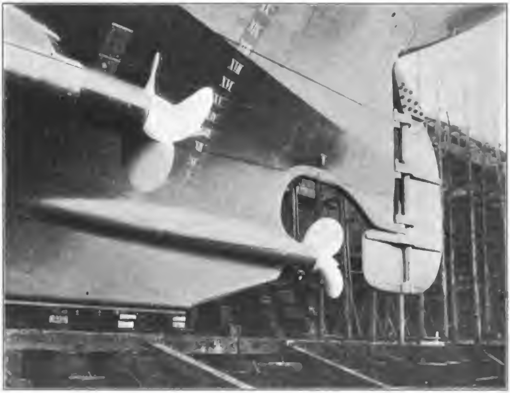
with Howden's forced draft, air being supplied by eight large fans, each driven by an independent inclosed steam engine.

The *Heliopolis* is of the following dimensions:

Length over all	545 feet
Breadth molded	60 feet 3 inches
Depth to shelter deck	38 feet
Draft loaded	22 feet 6 inches
Displacement in tons	15,000
Indicated horsepower	18,000
Speed at sea	20½ knots
Gross tonnage	12,000

a bath and toilet attached. Some of them include also a sitting room. The cabines de luxe are very large, and are fitted with wide berths, velvet pile carpets, luxurious settees and arm chairs, dressing tables, wardrobes, writing tables and book cases, and have hot and cold water supply. Electric lamp, electric bell and electric fans are fitted at convenient points for each berth, and electric fittings are also provided for heating curling tongs.

On the promenade deck amidships is the first saloon entrance. It has a handsome staircase leading to the bridge deck and from there to the shelter deck. Aft of this entrance



THE STERN OF THE SHIP, ON THE WAYS, SHOWING FORM OF RUDDER AND ARRANGEMENT OF PROPELLERS.

The hull is divided into separate watertight compartments by nine bulkheads. To further insure immunity from danger, a double bottom is fitted all fore and aft, divided by numerous watertight divisions into separate water ballast tanks. Each tank can be filled or emptied independently, so that the trim and draft of the ship can be adjusted at any time to suit the conditions of service. The total water ballast capacity is 3,500 tons. The ship is built to Lloyds three-deck and shelter deck 100 A1 class, and has seven decks, named in the following order from below: Lower, main, upper, shelter, bridge, promenade and boat deck. There are two pole masts, fore-and-aft rigged, with derricks for handling cargo.

In the passenger arrangements, the Fairfield Company has embodied the accumulated results of their long and varied experience in the designing of first class passenger ships. Accommodation is provided for 710 first class and 200 second class passengers. There are no third class passengers.

The promenade and bridge decks are entirely devoted to first class passengers. The staterooms are fitted up in a most luxurious manner. The cabines de luxe are a special feature of the ship, the ceiling and walls of each being treated differently; some are paneled in satinwood, others hung with tapestry. There are a number of these cabins, and each has

on the promenade deck is the music room, which is exquisitely finished in pure white. The furniture and grand piano are also in white. Immediately below the music room on the bridge deck is the library. This room is very large, is framed in oak, and has a handsome book case and other furniture, also of oak. Aft of the library is the first class smoke room, which is very comfortable and commodious, and well lighted, having large square windows around the sides, and a rectangular well above with ornamental fret work and provision for ventilation. The walls are framed in oak with hammered brass panels.

On each side of the promenade and bridge decks amidships there is a clear promenade of 10 feet 6 inches for first class passengers, and the bridge deck extends right aft to the stern.

On the shelter deck, and leading from the main staircase, there is the first class dining saloon. This room, which is about amidships, extends the full breadth of the vessel, and is 77 feet long. In the center of the room there are a number of round and oval tables, and at the ship's side in bays are small tables to seat five persons each. The saloon is arranged to seat 256 persons, but not more than 16 at one table. The side ports are placed in pairs close together, and have ornamental glass shutters. These, together with the large oval

dome in the center, afford splendid light to the saloon. At the fore end there is a piano, and at the after end an artistic sideboard. Forward of this saloon is a separate dining saloon for children. Aft of the first class dining saloon are the pantries, with the sculleries, galleys, bakery, confectionery, etc., forming one large kitchen, and equipped with all the most up-to-date machinery and appliances for cooking.

Aft of the pantries is situated the second class dining saloon. In the center are the usual long tables, and at the sides a number of tables each to seat eight persons. This saloon is 60 feet long by 50 feet broad, and is arranged to seat 180 persons. Passing through double swing doors, the second class social hall is reached. Aft of the social hall is the second cabin smoke room. This, like the first class smoke room, is arranged with cosy corners, arm chairs and small tables.

Leaving this deck and going below, the upper deck is reached, with two side passages all fore and aft, the one on the port side being reserved for the use of the ship's company, while that on the starboard side is for the accommodation of passengers. On the starboard side are staterooms, and on the port side engineers' quarters, also rooms for stewards, butcher, baker, barmen, chef and cooks, cold store rooms for ship's provisions, and a printer's shop.

The forward part of the main deck is all occupied by two and three berth cabins for first class passengers, and on the same deck aft similar cabins are arranged for second class passengers. The lower deck is all cargo space, part of it being insulated for carrying frozen meat. The mail and specie rooms are on this deck. Under the lower deck is the ship's hold.

Returning by the stairways to the main deck, and entering the hoist, the passenger is carried up to the promenade deck. On the boat deck is the café, a special feature of the latest liners. This room extends right across the full breadth of the deck-house, and is 63 feet long. It is furnished with small tables to seat four persons at each, and is capable of seating 88 persons. There are a special kitchen, scullery, larder, glass room and wine room, etc., on the boat deck for supplying café.

The officers' messing and sleeping accommodation is situated forward of the café. The wireless telegraph office is also on the boat deck.

The ventilation arrangement is a special feature of this ship, and is on the thermotank system. The installation consists of a number of large thermotanks distributed over the various decks. These tanks assimilate air from the open, and when charged can reduce or raise the temperature of the air to any degree desired. This done, the air is distributed by centrifugal fans through trunks to any part of the ship. In

THE STERN, JUST BEFORE THE SHIP WAS LAUNCHED.

THE HELIOPOLIS WAS FLOATED FROM THE YARD OF THE FAIRFIELD SHIPBUILDING AND ENGINEERING COMPANY ON MAY 28, 1907.

addition to this system, there are electric exhaust fans in the smoke rooms and in the dining saloons.

There is a complete installation of electric light, which consists of three sets of combined engines and dynamos of compound type, Siemens & Bellis make, any two of which are capable of generating and supplying light equal to 28,800 candlepower, also supplying the necessary current for a large number of cargo lamps of 200 candlepower each, and to the thermotank motors, fans and electric passenger hoist. The current is transmitted by insulated cable, all wiring being done on the double-wire distribution box system.

The main switchboards are fitted with ammeters, voltmeter and switch, pilot lamps and switches, double pole switches and fuses for each of the generators, and change-over switches and double pole fuses for each of the main circuits. The instruments are of the moving coil type, and the whole switchboard is arranged for easy handling, each switch being distinctly marked with the name of the circuit which it controls.

The steering wheel on the navigating bridge is in direct communication with steering gear aft, on the latest telemotor principle.

Another feature of the ship is the Clayton fire extinguishing arrangement. The extinguisher is capable of generating and delivering by means of pipes to any part of the ship upwards of 25,000 cubic feet of fire extinguishing gas per hour. The machine extracts air from the compartment, simultaneously delivering sulphur dioxide into it. When the fire is extinguished, the sulphur dioxide is withdrawn by suction. By the same machine, fresh air can be simultaneously injected into the compartment. It will thus be seen that the usefulness of the machine is not confined to fire extinguishing purposes, but it may be used either for ventilation by extracting foul air and delivering fresh air, or for disinfecting any compartment in the ship.

The *Heliopolis* and her sister ship, *Cairo*, also building at Fairfield, are for the new express, mail and passenger service between Marseilles and Alexandria.

The speed trials of the *Heliopolis* took place on the Firth of Clyde from the 6th to the 9th of November. These consisted of a progressive trial of four double runs on the measured mile at Skelmorlie, and two runs of twelve hours each, one of these being at full speed. During the twelve hours at full power the mean speed was 20.75 knots, with the turbines making about 370 revolutions per minute and developing 18,000 horsepower. The contract speed was 20½ knots.

Vessel Tonnage Movement in the Principal Ports of the World.

There has been much discussion regarding the total tonnage of entrances and clearances of ships in the principal commercial ports, and claims have been made from time to time that this port or that one had the greatest tonnage movement to be found anywhere. The following statement, covering in other ports the calendar year 1904, and in New York the fiscal year ended June 30, 1905, will be of interest in this connection. The figures have been compiled by the Bureau of Statistics in the Department of Commerce and Labor, and are taken from official sources. They represent net register tons and foreign trade only, no coasting or fishing services being included:

Port.	Entered.	Cleared.	Total.
Hong Kong*	9,680,642	9,652,454	19,333,096
New York	9,630,853	9,311,527	18,942,380
Antwerp	9,373,703	9,339,707	18,713,410
London	10,788,212	7,850,947	18,639,159
Hamburg	8,681,534	8,770,675	17,452,209
Constantinople	......	......	15,066,621
Liverpool	7,986,584	6,730,206	14,716,790
Rotterdam	7,181,374	6,764,960	13,946,334
Cardiff	4,795,406	8,324,066	13,119,472
Singapore*	6,175,905	6,155,848	12,331,753
Shanghai	6,076,279	6,105,519	12,181,798
Colombo	5,195,822	5,154,094	10,349,916
Marseilles	5,061,912	4,645,467	9,707,379
Lisbon	4,820,940	4,783,209	9,604,149
Gibraltar	4,402,552	4,388,425	8,790,977
Funchal (Madeira)	4,429,175	4,316,018	8,745,193

A similar statement for the calendar year 1906 shows a healthy increase in nearly all of these ports.

Port.	Entered.	Cleared.	Total.
New York (*d*)	11,383,345	10,472,601	21,855,946
Hong Kong (*a*, *)	9,899,049	9,879,127	19,778,176
Antwerp (*a*)	9,864,528	9,800,149	19,664,677
London	11,222,542	8,185,400	19,407,942
Hamburg (*a*)	9,408,000	9,516,000	18,924,000
Shanghai (*b*)	8,556,508	8,816,454	17,372,962
Rotterdam (*a*)	7,868,819	7,696,416	15,565,235
Liverpool	8,145,441	7,125,417	15,270,858
Constantinople	......	......	15,108,000
Montevideo (*b*)	6,806,000	6,700,000	13,506,000
Cardiff	5,295,331	8,193,312	13,488,643
Marseilles (*a*)	6,410,384	6,578,082	12,988,466
Singapore (*a*, *b*, *)	6,362,458	6,401,916	12,764,374
Kobe	5,432,880	5,305,123	10,738,003
Colombo (*a*)	5,179,045	5,139,749	10,318,794
Newcastle	4,334,783	5,635,064	9,969,847
Genoa (*a*)	5,132,159	4,797,722	9,929,881
Moji (Japan)	4,507,377	4,419,933	8,927,310
Gibraltar (*a*)	4,018,495	4,108,021	8,126,516

There are many other ports of considerable prominence for one reason or another, which fall below 8,000,000 tons for total figures. These include Dover, 5,160,156; Glasgow, 4,798,826; Southampton, 4,219,305; Boston (*d*), 5,263,002; Philadelphia (*d*), 4,665,059; San Francisco (*d*), 1,734,429; Havre (*a*), 6,578,103; St. Petersburg (*a*), 3,131,398; Copenhagen (*a*), 5,396,332; Naples (*a*), 7,428,891; Malta (*a*), 7,436,517; Alexandria, 6,347,029; Aden (*e*, *), 5,957,722; Bombay (*e*), 3,128,394; Calcutta (*e*), 3,279,683; Cape Town (*c*), 6,874,682; Yokohama, 6,517,922; Nagasaki, 5,385,248; Valparaiso (*a*), 1,947,000; Buenos Aires (*c*), 7,470,437; Rio de Janeiro (*a*, *b*), 6,205,015; and Havana (*a*), 4,497,665.

It will be noticed that a number of ports have changed places in order of size. New York, which was second in the first list, has now become first by a large margin, while Hong Kong, Antwerp, London and Hamburg, following in the order named, are having a close fight for pre-eminence in this respect. It should, of course, be noted that the figures are not all of the same date, and that in consequence some allowance must be made. For instance, the figures for New York are latest of all, and hence should be discontinued to a certain extent to put them on a par with the others. The great growth indicated for this port, however, amounting to not less than 2,913,566 tons in two years, represents the very large increase of 15.4 percent during this period. This is a higher figure than the rates of increase of any of the others among the four or five leaders, and would seem to indicate that this, the only port in the United States which has a foreign-going tonnage movement of more than 6,000,000 tons per annum, has become the premier port of the world, and, unless all signs fail, will continue to hold this position for some time to come.

* Excluding junks and other native craft.

a, 1905; *b*, all tonnage, foreign and coasting; *c*, 1904; *d*, year ended June 30, 1907; *e*, year ended March 31, 1906.

THE HEATING AND VENTILATING OF SHIPS.*

BY SYDNEY F. WALKER, M. I. E. E.

Both heating and ventilating have only within recent years received serious consideration, either ashore or afloat. On shore heating has been confined, in the United Kingdom, almost universally to open coal fires, and ventilation to opening windows and doors. In America and Canada, heating on shore has been more seriously studied for some considerable time, because of the more severe conditions of climate at certain times of the year. With the comparatively mild winters of the United Kingdom, a well warmed room in cold weather has been sufficient for most individuals. In parts of America, and practically the whole of Canada, the severe winters have obliged householders to provide means of heating, not only living rooms, but passages, halls, etc., and this has led gradually to the development of the improved forms of heating and ventilation that are now common on both sides of the Atlantic.

The same remarks apply practically to heating and ventilating on board ship. In the great majority of cases until recently, and in a very large number of ships, particularly in

FIG. 1.—CABIN OF AN OHIO RIVER TOWBOAT, SHOWING THE OLD FORM OF CLOSED HEATING STOVE AND PIPE.

small craft, even now, just as in large numbers of private houses on shore in the United Kingdom, heating has been accomplished either by the familiar stove, standing in the middle of the mess room, with its chimney passing up through the deck above, as shown in Fig. 1, a cabin on an Ohio river tow boat, or in certain cases through the side of the ship. In the saloons of passenger steamers, and the mess rooms of the executive officers in the better class of tramp steamers, the iron stove has been displaced by the fireplace, built into a fireproof recess, similar to those employed on shore. Ventilation on board ship has been confined to opening ports and hatchways when the weather allowed, assisted by an occasional windsail, and by ventilators leading from the different messes, saloons, etc., to the upper deck.

The advance of modern science, and particularly the advance of medical science, has shown this method of ventilation, or absence of ventilation, to present very grave dangers to those on board who have to remain below; in emigrant ships, for instance, in which large bodies of men, women and children, often of all nationalities, often of not too cleanly habits, often again of not too robust health, have been confined between decks, with very little air from outside penetrating to them whenever the weather was sufficiently bad to oblige ports to be shut and hatchways to be closed.

Modern medical science teaches that in such cases diseases, sometimes unknown to their possessors, are rapidly propagated. It is now known that diseases are communicated by minute organisms variously known as bacilli and bacteria, and these breed rapidly under the conditions named. The same kind of thing rules on shore, where large numbers of men and women are confined in small spaces, badly ventilated, as in some of the workrooms, etc., that were common not long since in the east end of London. In addition, it is well known that consumptives are frequently sent to sea with the idea that the sea air will arrest the progress of the disease, and if there be any of these among the passengers confined between decks in bad weather, the results can only be the making of additional consumptive patients. Air is to bacilli, and to the various emanations from unhealthy subjects, what water is to dirt.

Water, we know, if properly applied, dissolves dirt and other noxious substances, and if allowed to do so, will carry them away. One reason why Englishmen and Americans are so generally healthy and so usually vigorous is because they are fond of water. Some of the other nations of the continent of Europe, as we know, and particularly some of those from whom large portions of the emigrants are drawn, are not so fond of water, and the consequence is they bring to the steerage quarters germs that, if allowed under the conditions named, will breed disease, even where it is not already present or incipient.

There are two methods of ventilating that may be applied both to buildings on shore and to ships afloat. One corresponds to the weekly thorough cleaning that the good housewife bestows upon every room in the house. As we are sometimes painfully aware, every object in the room is displaced, and every corner is subject to the vigorous cleaning process, under which disease germs cannot exist. Similarly to rooms on shore, the 'tween decks, cabins, etc., afloat may be cleansed by throwing them open to a vigorous current of air, when the weather allows, by opening all hatchways, all ports, and moving everything and seeing that the air current penetrates to every corner, just as the housewife's broom does in the cleansing process.

The other method, which is more rational, and which modern science has approved, is to direct a current of air from the place where it is to be obtained in its purest form into each living room, as far as possible into each corner of it, and to carry it away in a direction different from that at which it entered, carrying with it the disease germs, the emanations referred to, and the carbonic acid that has been formed by the breathing of the occupants of the quarters, and also in minute particles of dust that may be present. Certain conditions are necessary in connection with the ventilating air current, just described. It must be a very gentle current that cannot be felt, except under special conditions, such as when passing through the tropics. In temperate climates what is known as a draft must be avoided, and that is one reason why the ventilation of houses is somewhat difficult. By a draft is understood a current of air passing through a room or living place, such as a cabin or mess room, at such a velocity that the heat of the body is carried off more rapidly than the circulation of the blood, and the chemical action of the food, etc., supplies it, with the result that persons subjected to the draft catch cold.

The rationale of the process is as follows: Air, when passing over any object at a higher temperature than itself, abstracts heat from it, every cubic foot of air passing over (say) a human body abstracting a certain quantity of heat, in proportion to the difference of temperature between the air and the body, and in proportion to the velocity at which the air travels, up to a certain limit. In addition, as we know, the human body is constantly perspiring and there is always a minute film of moisture present on the skin. The quantity of moisture present, due to this cause, varies with the individual. Some persons perspire very freely, others hardly at all. Again,

everyone perspires more when the weather is warm than when it is cold, and again more under exertion than when at rest. In any case, the air current, passing over the body, converts the moisture present on the skin, and which penetrates through the clothes, etc., into vapor, and in doing so, extracts heat from the body. Water and other liquids, it will be remembered, can assume the form of vapor only by absorbing into themselves a certain definite quantity of heat. When the perspiration upon the body is transformed into vapor, nearly the whole of the heat required to enable it to become vapor is taken from the body itself. This is the reason why perspiration is so good in hot climates, and why doctors, and those who are accustomed to the tropics, are so insistent upon the production of perspiration. In the tropics one frequently hears "old stagers" say they feel all right as long as they can perspire. The evaporation of the vapor cools the body, and a gentle current of air, passing over the body, accomplishes this.

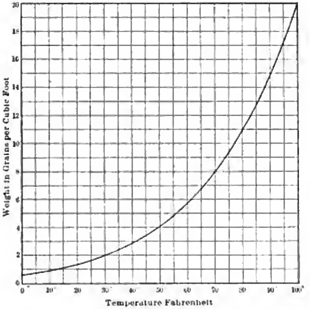


FIG. 2.—CAPACITY OF AIR FOR VAPOR, AT VARIOUS TEMPERATURES.

In temperate climates, however, and in cold climates, where it is required to keep the heat in the body, a draft of air passing over it tends to cool unduly the particular part over which it passes, and to produce the unpleasant feelings we know as catching cold. Consequently, one of the first requirements is that the velocity of the air in temperate climates should be such as not to be felt. In the institutions on shore, for instance, which have adopted mechanical systems of ventilation, it is impossible to tell, without making special tests for the purpose, that any air current is passing.

SPECIAL REQUIREMENTS ON BOARD SHIP.

The requirements of ventilation and heating on board ship are different in a great many cases from those on shore. On shore, even in countries where there are large variations of temperature, as in the United States, Canada, Russia, etc., different temperatures are confined to certain parts of the year. Thus, during certain months of the winter, a very low temperature rules, while during certain other months of the summer a high temperature may rule. In such countries as the United Kingdom, the variation of temperature is usually very gradual, indeed. On the other hand, a ship trading (say) between Liverpool or New York and the Cape of Good Hope, or between Liverpool or New York and San Francisco, will experience wide differences of temperature in very short periods of time. Thus, supposing the ship leaves either Liverpool, New York or Boston in the depth of winter, for San Francisco, the temperature will at first be very low; it will gradually increase until in the tropics it will be very high. It will again decrease, and in the neighborhood of Cape Horn may be very low again, gradually increasing once more as she makes her "northing," and so on.

Further, there is a very important matter that has to be considered in connection with the ventilation of ships which pass through the tropics, and of others which go to other climates, viz., that of the humidity of the atmosphere. Humidity, as we know, varies considerably, and the variation has a very important bearing upon the effect of a current of air upon the human body. It was mentioned above that in the tropics, for instance, if one is perspiring, a gentle current of air has a cooling effect, by evaporating the perspiration, but this is only on condition that the atmosphere itself is not already saturated with moisture, as it is at certain times of the year, and as it may be quite easily between decks at almost any time. The capacity of the atmosphere for moisture varies with its temperature, according to the curve shown in Fig. 2. It will be noticed that the capacity for moisture goes up very rapidly after a temperature of 40° F. is reached. Thus, at 40° F. its capacity is 3 grains per cubic foot; at 60° F., 6 grains; at 80° F., 11 grains, and at 100° F., 20 grains. Dry air, therefore, at a high temperature has a larger capacity for moisture than dry air at a lower temperature.

But the ability of the atmosphere to evaporate moisture from any substance, or body of liquid, depends very largely upon its own condition of saturation. Thus, if it is already fully saturated with moisture, no evaporation will take place from the body over which it passes, and under certain conditions, deposit of moisture may even take place from the atmosphere onto the body. The question whether moisture shall be evaporated from any body, or be deposited from the atmosphere on the body, depends upon the tension of the vapor issuing from the body, as opposed to the tension of the vapor present in the atmosphere. The tension of the vapor in the atmosphere depends upon its degree of saturation, while the tension of the vapor issuing from the body depends upon its temperature.

Hence, when the atmosphere is in the condition we know as "muggy," that is to say, when it is saturated with moisture, as it is in the tropics just before the rainy season, and as it may easily be between decks, and particularly in the stoke hold under certain conditions, even with a ventilating current passing, the cooling effect that should be obtained is not present. On the other hand, with a warm, dry air, used as a ventilating current, and having a large capacity for moisture, as explained above, the evaporation from the body, even with a comparatively gentle air current, may be so great as to produce a serious cooling effect, though the air itself is comparatively warm. Hence, where a ventilating air current is employed, in temperate or cold climates, it may be necessary to add moisture to the air current, in order that the cooling effect, owing to the possible evaporation from the body, may be reduced. It will be understood that while in a hot climate, warm, dried air passing over warm bodies produces a delicious cooling effect; in temperate or cold climates, during the cold season, the same warm dry air may produce an undue cooling effect, a cooling effect that is undesirable, for the same reason, owing to the evaporation of the perspiration. Hence it is necessary in some cases to add moisture to the air current. It is an axiom among heating and ventilating engineers that a moist air current of comparatively low temperature is "warmer" than a dry air current of a higher temperature.

DIFFICULTIES PECULIAR TO SHIP WORK.

One of the difficulties in connection with both heating and ventilating on board ship is the fact that in bad weather the

ship "knocks about." There may be said to be two distinct problems before the heating and ventilating engineer in ship board work, viz., that presented by the ordinary ship, which behaves like a cork when there is a sea on, and that presented by the modern ship, which keeps a practically even keel. Modern naval architects who have designed warships, and those who have designed ocean liners, have both striven after the same thing, a steady platform under all conditions, but for totally different reasons.

A steady platform is required by the modern warship in order that the guns may be properly fought. In the battle of the Sea of Japan, it is stated that the Russian gunners were very much handicapped by the fact that their ships, being very heavily loaded with coal, and not being designed to keep an even keel, rolled very much in the heavy sea that was on, while the gunners were not practiced in firing with the ship rolling. Even the most practiced gunlayer cannot do so well with a ship rolling as with a ship steady, and hence every effort has been made, and with apparently considerable success, to provide a steady platform. The naval architects who have designed the ocean liners have striven after the same results, and with apparently almost equal success, in order to neutralize the effects of *mal-de-mer*. With the increased ocean traffic, particularly between the United Kingdom and America, the ship which can carry its passengers, even through a gale of wind, with little danger of sea sickness, commands the largest share of the traffic.

Evidently, ventilating and heating problems are very much simpler in these ships than in those which knock about, and the more a ship knocks about, the more difficult are the two problems. One hears tales of ocean tramps, generally of the older type, rolling so badly, if there has been any sea on, that the galley fire could not be lighted, say between Bilbao and Cardiff, and so on. The additional difficulties presented by a rolling ship in the problem of ventilation and heating will be dealt with later on, but meanwhile it will easily be understood by anyone who has sailed in a ship which rolls very much that everything is very much strained. In old wooden ships it was quite common to see the ship's side bend inwards, as that side rolled downwards, the resilience of the timbers assisting to bring her up again. The iron shells of modern ships have not the resilience of the old wooden ships, but they must give to a certain extent, and every roll and every pitch strains every bolt, duct, etc., and produces eddies in water, air, and so on, that are used for heating and ventilating.

Another difference that arises between ventilating on shore and ventilating on board ship is the air current created by the passage of the ship through the water. On shore the wind has to be taken into account in designing systems of ventilation for buildings, and the wind must also be taken into account in connection with ship ventilation, and in some cases with heating, but the passage of the ship through the water is constant, and by itself it creates a powerful ventilating current. For instance, the maximum velocity of air in the ordinary ventilating air current on shore is 5 feet per second, and many ventilating engineers prefer even the lower velocity of 3 feet. The tramp steamer, running at from eight to ten knots, produces an air current of from 13 feet to 17 feet per second; at 16 knots, which is a very common speed at the present day, the velocity of the air will be 27 feet per second; while that of the *Lusitania* is somewhere in the neighborhood of 40 feet per second.

In hot climates, the air current produced by the passage of the ship will be very useful, indeed, in cooling the air between decks, etc., but in cold climates, and in particular in those regions in which whaling ships, sealers, etc., have to cruise, the air current is a very serious matter, and must be warmed, as will be explained, and possibly humidified, before being allowed to penetrate between decks.

Ventilation of ships has one important advantage over ventilation on shore in some cases, notably in some of the large and smoky towns, inasmuch as there is no difficulty whatever in obtaining absolutely pure air, rich in ozone, the most powerful oxidizing agent available, and there is a complete absence of any necessity for cleansing the air. On shore, in large towns, one of the most important matters in connection with the ventilation of public buildings consists in the purification of the air. Various devices are employed, and in all of them the quantity of dirt,—of black coaly matter such as steamers too often have distributed over their decks when burning bad coal,—that is deposited in the receptacle provided for it, is astonishing.

(To be continued.)

THE CUNARD STEAMSHIP MAURETANIA.

Our description in October of the *Lusitania* will apply almost equally well to her sister ship. The difference between the two ships from a fundamental point of view is slight, but a number of minor differences, and particularly differences in the decorations, have been made. The present ship was built by Swan, Hunter & Wigham Richardson, Limited, Newcastle-on-Tyne, and has been supplied with propelling machinery by the Wallsend Slipway & Engineering Company, Limited. The general dimensions are as follows:

Length over all	790 feet
Length between perpendiculars	760 feet
Breadth, molded	88 feet
Depth, molded	60 feet 6 inches
Gross tonnage	33,200
Mean load draft	33 feet 6 inches
Corresponding displacement in tons	38,000
Designed horsepower	68,000
Contract speed (one round trip per year)	24.5 knots

It is thus seen that the vessel exceeds the *Lusitania* in depth by 1½ inches, and in gross tonnage by 700. Provision is made for 2,165 passengers and a crew of 938, making a total of 3,103. Of the passengers, 563 first class are carried in 253 staterooms, 35 of which are each for one passenger only; 464 second class passengers are carried in 133 staterooms; while the third class, 1 138 in number, are carried in 278 rooms with from two to eight berths each. The seating accommodation of the various dining saloons are 470 in the first class, 251 in the second class and 520 in the third class.

While externally and internally the *Lusitania* and the *Mauretania* are similar in the main features of their design and arrangement, there are differences in detail that are readily apparent. What most strikes one on approaching the *Mauretania* is the difference in the overhead deck erections. Where the *Lusitania* has square trunks with hinged covers for the ventilation of the stokeholds, the newer ship has wide-mouthed ordinary cowls, and as they are a good deal higher, they somewhat enhance the appearance of the vessel. Then, again, the promenade deck and also the boat deck above project over the shelter deck by about two feet for nearly three-fourths of the length of the vessel. This, on the two decks on which this arrangement has been carried out, makes a very appreciable addition to the free space for promenading on both sides of the ship.

Internally, while the arrangement of the various apartments is almost identical in the two vessels, there is an entire contrast in the architectural treatment and decoration.

Speaking broadly, the prevailing aspect of the public rooms in the *Lusitania* is one of lightness and brightness, the outcome of a liberal use of light-colored enamels and gilt. In the *Mauretania*, on the other hand, costly woods in their natural colors are relied upon for decorative effect, producing what might be described as an impression of handsomeness and substantiality. Both schemes of decoration are successful in their own way, and preference for the one or the other will differ according to the taste or temperament of the individual. The dining saloon and upper saloon in the *Mauretania* are in oak in the Francis I. style, beautifully carved. In the main entrance hall and staircase the design is Italian renaissance, carried out in French walnut, and the same style in the same wood, with the addition of satinwood inlay, is used with fine effect in the smoking room. The library is done in sycamore of a beautiful grey shade, and is furnished in Louis XVI. style, and the same style is carried out in the lounge and music room in mahogany, with large tapestry panels flanked by duplicate pillars of grained marble. The staterooms and regal suites of rooms are variously treated in Adams, Georgian and Sheraton styles.

Equal taste, and not much less expenditure, have been bestowed on the second class accommodation, in which the dining saloon is in oak after the Georgian period, the drawing room in maple, in a modified Louis XVI. style, the smoking room in mahogany, and the lounge and entrance hall in polished teak. A new feature in the second class accommodation is a large deck shelter, which must add greatly to the comfort of the passengers in cold or stormy weather. In their degree, the third class passengers have also been liberally dealt with, both in their dining saloon and sleeping quarters, the latter being exceptionally large and airy, while the former is nicely finished in polished ash.

THE WRITING ROOM.

THE SMOKING ROOM.

THE MACHINERY.

The ship is propelled by steam turbines of the Parsons type, some of the illustrations of which, before being fitted to the vessel, will be found in our issue of November, 1906. The total heating surface of the twenty-five boilers (twenty-three double-ended and two single-ended cylindrical) is 159,000 square feet (3.65 acres); the grate surface is 4,060 square feet, and the boilers are fitted for Howden's forced draft. The boilers have shells of high tensile steel, and discharge the products of combustion into four elliptical funnels with outer

casings measuring 26 feet fore and aft and 19 feet athwartships. The 192 furnaces are of the Morison suspension type, built by the Leeds Forge Company. Each furnace has a separate combustion chamber.

The turbine rotor wheels, which are usually two in number, one at each end of the drum, are supplemented in this case by two inner wheels to stiffen the drum in its great length. The line shafting has a diameter of 22 inches, but in the bearings it is increased to 36 and 52 inches, a conical section being interposed. The bearings are about 5 feet in length. The propellers have a pitch of about 16 feet, and operate at a slip of about 15 percent.

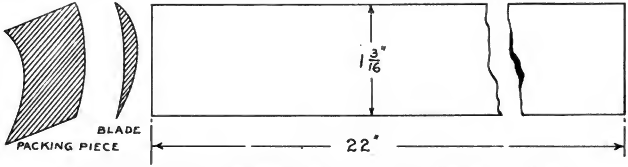
THE MAURETANIA AT FULL SPEED AT SEA, SHOWING THE ARRANGEMENT OF VENTILATORS AND FUNNELS.

The disks and gudgeons, as well as the shafts and drums of the turbines, were made of Whitworth fluid pressed steel, all stiffeners being solid and integral with the drums, with the idea of getting maximum strength and rigidity with minimum weight, and also to avoid distortion or straining in heating up or cooling down. The high-pressure drums are 96 inches in diameter, and the rotors, including bearings, are 45 feet 8 inches long. The blades, in eight stages, vary from 2½ to 12 inches in length. The low-pressure drums are 140 inches in diameter and 48 feet 2 inches long, with eight stages of blades, varying from 8 to 22 inches in length. The astern turbine drums are 104 inches in diameter and 30 feet 1 inch long, with blades from 2 to 8 inches, in eight stages.

In the rotors and lower half casings the usual method of fitting blades has been followed. This consists in first fitting a fixed stop piece, which sets the correct blade angle. This is held in position in the rotor groove by means of a steel wedge. The first blade and packing piece are then inserted, and, after a number are in position, the set is tapped up with a hammer and tool and afterwards calked. The blades are held together and stiffened by wire binding, the brass wire being fitted into a small saw cut near the upper end of each blade, and passing on to the successive blades in turn. This forms a brass ring extending around the circle of blades near their upper end. In longer blades two such rings are employed, and in the 22-inch blades of the low-pressure turbines are three sets of wires. A fine copper wire is lashed

around each blade and its brass binding wire, to hold everything solidly in place, and the entire connection brazed over by means of silver solder.

The turbine blading in the upper half of the casings is on the Willans & Robinson system. "The blade roots are fitted into two solid half rings, which are accurately divided off by machine cuts, and thus give uniform adjustment to the blade pitches and angles throughout. At the outer ends or tips the blades fit, by means of a tang, into a channel-shaped brass ring or shroud. The blading is completed independently in two or more sections before being fitted into the casing. The channel-shaped shroud can be adjusted to reduce the tip clearance and, should fouling occur, the channel ring would wear away and give its own clearance, or would perhaps bend over, thus protecting the blades and eliminating the danger of blade stripping. It will be noted that in this system no separate packing pieces are required, and that the brass wire binding and upper wire lacing are required only in the case of the very long blades near the low-pressure end of the low-pressure turbines."*



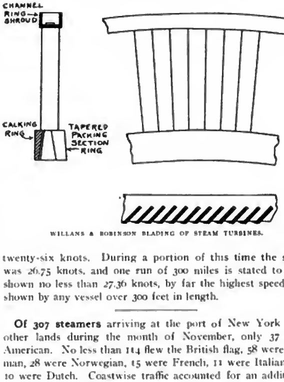
A FULL-SIZED DETAIL OF ONE OF THE LOW-PRESSURE BLADES IN THE MAURETANIA, WITH SECTION OF PACKING PIECE.*

The numerous pumps and other steam auxiliaries include a large number by G. & J. Weir, Limited, Cathcart, Glasgow. Others are by W. H. Allen, Son & Company, Limited, Bedford; J. H. Carruthers & Company, Limited, Glasgow; Clarke, Chapman & Company, Limited, Gateshead-on-Tyne, and Brown Brothers, Newcastle. In addition, there are pumps by the Liverpool Engineering Company in connection with the refrigerating plant, and pumps by J. Stone & Company, Deptford, London, for the Stone-Lloyd system of watertight bulkhead doors. Heating and ventilating is on the thermo tank system, by the Thermo Tank Ventilating Company, of Glasgow. Electric lighting is provided by four turbo-generators, each of 375 kilowatts, supplied by C. A. Parsons & Company, Limited, Heaton-on-Tyne.

The stern frame and bracket casting for the two inner propellers is a mammoth piece of work by the Darlington Forge Company, Limited, the weight being 104 tons. The strut frames for the outer propellers weigh together 48 tons, while the rudder, with an area of 420 square feet, weighs 63½ tons. The stem bar and stem foot piece are respectively an ingot steel forging weighing 8½ tons, and a cast steel member of 1½ tons.

There are twelve transverse bulkheads, and intermediate wing bulkheads are fitted in the side bunkers, dividing them into spaces about 40 feet long. Including the double bottom, there are altogether 175 watertight compartments. For a distance of nearly 350 feet alongside the boilers, the ship has a complete inner and outer skin, not only on the bottom, but also on the sides, being in this respect similar to warship construction.

The maiden trip (Nov. 16 to 22) of this ship was unfortunate by reason of tremendous seas due to a heavy gale. A spare anchor was torn loose, and it is estimated that the total loss in time occasioned by this and the storm aggregated seventeen hours. As it was, however, the distance of 2,780 nautical miles between Daunt's Rock and Sandy Hook lightship was covered in 5 days 5 hours and 10 minutes, at an average of 22.21 knots. On one single day, however, the ship covered 624 nautical miles, which makes the day's run at the rate of 24.99 knots. This is six miles more than was covered by the *Lusitania* in her highest day's run, a few weeks previous, and makes a new record. During this run the *Mauretania's* revolutions averaged 172 per minute, and did not exceed 180. On her trial trip, however, the revolutions reached as much as 194 per minute, the average speed for more than 1,200 miles having been a little more than twenty-six knots. During a portion of this time the speed was 26.75 knots, and one run of 300 miles is stated to have shown no less than 27.36 knots, by far the highest speed ever shown by any vessel over 300 feet in length.



WILLANS & ROBINSON BLADING OF STEAM TURBINES.

* J. W. Sothern: *The Marine Steam Turbine.*

Of 307 steamers arriving at the port of New York from other lands during the month of November, only 37 were American. No less than 114 flew the British flag, 58 were German, 28 were Norwegian, 15 were French, 11 were Italian and 10 were Dutch. Coastwise traffic accounted for an additional 208 steamers, all being American, and for 341 sailing vessels, of which 6 were barks and 335 schooners. The sailing vessels from foreign lands numbered only 69, of which 56 were schooners (38 British and 18 American). The total arrivals at the port numbered 925, or an average of 31 per day; of this number, 515, or 17 per day, were steamers, and 410, or 14 per day, were propelled by sails. The large use of sails in coastwise work is shown by the fact that 62 percent of the arrivals were sailing vessels, as compared with only 18 percent in the foreign trade.

FIFTEENTH ANNUAL MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

This convention took place in the Engineering Societies Building in New York on Thursday and Friday, Nov. 21 and 22, 1907. The first session was called to order by the president, Rear Admiral Francis T. Bowles, president of the Fore River Shipbuilding Company. The secretary-treasurer, in his report on the condition of the society at the close of the fiscal year, Oct. 31, 1907, showed a total membership of 801, as compared with 857 at the end of the previous year. By the admission of twenty-seven new members the present figure becomes 828. From the financial point of view, the society is in a flourishing condition, receipts during the year having aggregated $10,912 (£2,242). The total disbursements amounted to $10,663 (£2,191); included in these disbursements the sum of $5,505 (£1,131) accounted for the publication of Volume XIV of the *Proceedings*. The present resources of the society, after writing off doubtful accounts, aggregates $26,694 (£5,485) with no liabilities against it. This shows an increase during the year of $1,799 (£370).

The following elections of new members took place:

Members (15).—Carlton B. Allen, New Rochelle, N. Y.; Ernest H. B. Anderson, New York; J. I. Chaffee, New York; Ole G. Halvorsen, Camden, N. J.; Peter Cooper Hewitt, New York; Robert Hufner Laverie, Mariner Harbor, N. Y.; George M. Magruder, San Francisco, Cal.; Lewis B. McBride, Navy Yard, New York; Yoshihiko Mizutani, Kure, Japan; Charles A. Parsons, Wallsend-on-Tyne; Robert S. Riley, Providence, R. I.; James M. Smith, Collingwood, Canada; Robert J. Walker, Wallsend-on-Tyne; Axel Welin, London; Louis Williams, Superior, Wis.

Promotion to Member (6).—Harold Lee, Seattle, Wash.; Harold W. Patterson, New York; James G. Purdy, New York; John A. Spilman, Bath, Me.; Henry R. Sutphen, Bayonne, N. J.; Allen D. Woods, Jersey City, N. J.

Associates (4).—Bentley Gardiner, New York; Holden C Richardson, Newport News, Va.; Clayton M. Simmers, Puget Sound, Wash.; Henry A. Wise Wood, New York.

Juniors (8).—Frank E. Bagger, Brooklyn, N. Y.; John C. Burkhard, Ithaca, N. Y.; Constantine D. Callahan, San Pedro, Cal.; Fayette A. Cook, Ithaca, N. Y.; Wayne T. Dimm, Newport News, Va.; Dayton E. Herrick, Newburg, N. Y.; Harry A. F. Lynx, New York; Fritz A. Postel, Ithaca, N. Y.

In connection with the death during the year of Mr. Charles H. Haswell, one of the two honorary members of the society, the president appointed a committee, consisting of Messrs. Stevenson Taylor, Lewis Nixon, W. M. McFarland, Col. E. A. Stevens and Captain W. J. Baxter, to draw up suitable memorial resolutions. The other honorary member, Sir William White, K. C. B., was represented by a letter to the society, in which he regretted his inability to be present. The exercises terminated in the annual banquet at Delmonico's, on the evening of Nov. 22.

PAPERS READ THURSDAY MORNING.

No 1.—An Experimental Investigation of Stream Lines Around Ships' Models.

BY D. W. TAYLOR, NAVAL CONSTRUCTOR, U. S. N.

(This paper will be found at page 20.)

DISCUSSION.

William Hovgaard.—In connection with the stream lines it would seem that the location of the bilge keel might be largely dependent upon the flow of water around the sides and bottom of the vessel. In a torpedo boat some years ago we had difficulty in placing these keels, because of the greatly increased resistance. They were placed on a diagonal of the ship, and were located first amidships and then pretty well forward. In the latter position, it was found that they decreased the speed of the ship from 22.5 to 21 knots. It would appear from the present paper that they must have been across the line of flow of water.

H. C. Sadler.—It is interesting to note the rapidity with which a particle from near the surface of the water reaches the bottom of the ship, this being in the case of the cruisers at from 25 to 30 percent of the length, and in the slower and fuller vessels at 12 to 18 percent. Astern, in the shallow types of vessel, the flow is seen to be nearly horizontal, while the deeper types have here a diagonal flow.

A. A. Packard.—It would be interesting to know how the increased length of stream lines increases the resistance and the theoretical coefficient of friction. The efficiency of the propeller must also be affected by the direction of these lines, because the water is not flowing to the propeller in the direction of propulsion. In small fast boats it seems now to be the practice to fit a center keel instead of bilge keels. This makes very slight addition to the resistance, and is quite effective in overcoming rolling.

Frank B. King.—In connecting with the bilge keels, it would be interesting to know something about the direction of flow of water particles at a distance of two or three feet from the side of the ship.

D. W. Taylor.—It will be noted that the water flowing along the bilge of the ship is not in contact with any part of the ship near the bow. All the bow particles seem to seek the bottom of the vessel, and that touching the bilges comes from outside. Experience in the navy has shown that the resistance of a bilge keel is about equal to that theoretically due to its wetted surface, or even in some instances less. These bilge keels are in a plane which intersects the central vertical plane of the ship somewhere above the load water plane. As to the determination of the stream lines at some little distance from the ship, this was tested at the stern by means of a silk mesh coated with sesqui-chloride of iron, the result showing that the lines formed around the hull were carried some little distance out in about the same form.

Regarding the efficiency of the propeller in stream lines making such an angle with the direction of motion, it may be said that a slip angle of 10 degrees is quite unusual in the propeller itself, and that as a result inclinations of lines of 15 degrees would give a negative slip for some part of the revolution, and a very excessive slip for the rest. In such a case a horizontal shaft would give virtual inclination between the propeller axis and the lines of flow, due to the fact that the water is rising aft.

No. 2.—Some Experiments on the Effect of Longitudinal Distribution of Displacement upon Resistance.

BY PROFESSOR HERBERT C. SADLER.

ABSTRACT.

The object of the investigation was to determine the effect of distribution of displacement only. With this end in view, the length, breadth, drafts, coefficients of form, and hence displacement, were kept constant throughout the series. A set of lines representing one of the existing transatlantic intermediate type was taken as a basis or mean form. In general, the two extreme forms represent: First, a vessel with 40 percent parallel middle body, and hence rather fine ends; and second, a vessel with no middle body and rather fuller ends; the midship section being the same for all types. It may be remarked that none of the forms is particularly extreme or beyond the pale of practicability.

Although it is not safe to draw general conclusions, the results of the above experiments for this particular form may

be summarized briefly as follows: With a given set of dimensions, length, breadth, draft and with a given displacement, it is advantageous, so far as the forebody is concerned, to use a comparatively long middle body and fine bow. In the after body, however, better results seem to be obtained by adopting a form with a more gradual diminution of area from the midship section aft. The action of the propeller should not be lost sight of in the design of the after body, but, in the series under discussion, it will be noticed that the form of the after body and shape of the waterlines give a fairly easy form, even in the case of the fullest shape.

DISCUSSION.

A. A. Packard.—The results of this paper show that we can readily vary the relation in fineness between bow and stern, with the dual result of providing easier propulsion and a cheaper form to build.

D. W. Taylor.—In the work at the model basin in Washington we first made elaborate preparations for recording the contours of waves upon the models tested. In all our experiments, however, we have found that we could draw very little information from the wave forms, and hence we have practically discarded the idea. The curve of resistance is all that we can use in analysis. For instance, in comparing the waves shown in this paper for various forms of bow and stern, it would seem that the wave for a fine bow and full stern, as well as for fine bow and fine stern, should give much higher resistance than that for full bow and full stern. As a matter of fact, however, the result is quite the reverse, and in some cases the resistance figures up for the full form, showing the least wave, more than double what it does for the others.

H. C. Sadler.—Our object in measuring waves was to make some comparison between the positions of crests and the wavy form of the resistance curve. With regard to the form of model, it was found that fining away the ends gave much better results than a longer and more gradual running out of the lines.

No. 3.—Further Tactical Considerations Involved in Warship Design.

BY COMMANDER A. P. NIBLACK, U. S. NAVY.

ABSTRACT.

To properly handle a fleet in the approach to the attack and in action there is certain information which it is important to easily and quickly ascertain, and certain orders or information which must be transmitted to the other ships or to other persons in each individual ship. These may be considered under three heads: (1) Interior communication; (2) Exterior communication (signaling); and (3) Tactics.

The proper point of view for the average line officer should be to make the most of the ships as they are. There is too little battle practice, *as if in battle*, to enable anyone to pronounce our present arrangements defective, except in minor details. Gunnery is the best test of ordnance. Battle tactics is the best test of the battle qualities of our fleet. There is to-day in our navy a tendency to formulate tactics rigidly on the basis of rectangular movements. At the risk of being heretical, after so many years of being very orthodox, the writer is inclined to believe that, in "sparring for position" in the approach to the attack, oblique movements have a possible use, rare it is true, but sufficient to justify a recognition of their not being altogether anathema.

DISCUSSION.

William Hovgaard.—It seems almost an axiom that no one of importance in a battleship engagement should be outside of the armor protection. In the battle of the Sea of Japan the flagship *Suvoroff* was put out of action almost entirely by shell fire. These shells were very sensitive and carried heavy charges. They were readily exploded by contact with even the slightest sort of resistance, and gave rise to a perfect hailstorm of splinters, besides the effects of blast and the generation of such heat as to set fire to anything inflammable in the vicinity. It seems to me that the conning tower of the future will have to be two stories high, with the ship controlled from one story and the guns from the other. It will be larger and much heavier than at present, and will have radial shields for minimizing danger from splinters.

Lewis Nixon.—The position of the officer in command will probably be directed by the exigencies of the moment. Non-magnetic armor will have to be provided, in order that the compass may be placed within its protection.

The present boiler and line of piping under heavy pressure must go. The operation wears out the men and presents very serious problems, in addition to the danger. The use of crude oil as a fuel saves the men, but does not solve the other problems. We must do away with cumbersome uptakes and funnels, and with all necessity for such excessive ventilation as is now required to keep the temperatures below at a livable figure. The internal combustion engine, coupled in the case of larger vessels with the gas producer, is a splendid solution, and is one which is already at hand. The heat of the exhaust can be put to many uses, notable among which might be mentioned the distilling of sea water for the use of the crew. It is understood that steam turbines have not solved the problem of reducing weights, but that in many cases they are actually heavier than the engines they have displaced.

P. Hagstrom.—Battleship and cruiser turbines have turned out to be lighter than their corresponding reciprocating engines. With destroyers there is not much saving. When cruising turbines are fitted, there is required a considerably greater length than with reciprocating engines, but not so much height.

F. T. Bowles.—In spite of what is said against the turbine, it must be remarked as a matter of common knowledge that the turbine has done and is to-day doing what no other engine ever built has ever done.

A. P. Niblack.—Steering gear, as at present fitted to the American navy, is probably as good as any in the world. At the same time there are frequent cases where a ship has to drop out of station for repairs to the gear, lasting often not longer than ten minutes. The great disadvantage in the use of screws turning inboard is that they make the vessel steer badly. Range finders, as at present fitted, jar out of position under the shock of firing heavy guns. Even under such conditions, however, they remain good for attaining relative results; that is, for determining the relation between the range at one moment and that at some subsequent moment.

PAPERS READ THURSDAY AFTERNOON.

No. 4.—Submarines of Battleship Speed.

BY MASON S. CHACE.

ABSTRACT.

Existing types of submarines used in conjunction with mines tend to limit the rôle of the battleship in wars of the future to fighting on the high seas. If submarines are to fight battleships at sea and to threaten their existence, they must be of a type which possesses a surface speed at least equal to that of the battleship, combined with sufficient endurance to enable them to get within striking distance. Without such speed they will not be able to so place themselves as to utilize their ability to fight as submarines.

The military value of a fighting ship comprises many factors offensive and defensive, including speed and endurance. Different percentages of the total displacement are

assigned to each of these dependent factors in different classes of ships, variations in the distribution of the displacement differentiating one class of ship from another class. Within the limits of any one class these variations in weight distribution, from ship to ship, are comparatively small, but there still remain numberless possible combinations or compromises which can be made. The rule of compromise applies to large ships as well as to small ones, althougb often less apparently in the case of the former than in that of the latter.

When submarines of small displacement are proportioned for high surface speeds, they can attain these speeds and also have sufficient battery power to do effectual submerged work. They must of necessity be vessels of limited endurance. A harbor or coast-defense submarine can do much work in the way of catching an enemy if it has a surface speed of 12 to 15 knots, of which the vessel making only 10 knots is incapable. If high surface speeds, combined with great endurance, are desired for effective off-shore work, larger displacements are necessary. In such vessels it may be found advisable to fit triple screws, the central screw to be utilized for electric propulsion, and when cruising at an economical speed, driven by a small auxiliary engine; the auxiliary engine could also be used for charging the storage battery.

DISCUSSION.

William Hovgaard.—In a large boat it will be necessary to limit the depth of submergence of submarines on account of the prohibitive requirements for strength at great depths.

W. D. Taylor.—Battleships have no antidote against the submarine. All they can do is to run out of the way. The submarine is amply armored by the water in which she is immersed, and is practically immune from attack. In experiments on the resistance of submarines, certain models have shown critical speeds, on reaching which they would dive at once. This is supposed to have been the phenomenon which caused the loss of a French submarine some months ago. It should be noted, however, that these critical speeds are high, being about $1.3\sqrt{\text{length}}$. This is seen by the curves to be well beyond the final hollow in the resistance curve, and hence need not be apprehended for vessels of the usual design and construction.

M. S. Chace.—It has been suggested to give the elliptical section of the hull forward a vertical major axis, while that aft could have a horizontal major axis. This would be particularly applicable in case three screws were fitted. What the submarine needs in the way of speed is greatly increased speed on the surface of the water. The speed submerged is a matter of comparatively minor consideration, as is also the submerged radius of action. Surface speed, however, is absolutely required, in order that the submarine may get within striking distance of its enemy.

No. 5.—Motor Boats for Naval Service.

BY NAVAL CONSTRUCTOR L. S. ADAMS, U. S. N.

ABSTRACT.

Although this paper applies, primarily, to the introduction of motor boats into the naval service, and to gasoline engines of the lower powers, such as those in successful operation at the present time, a proposed gasoline (petrol) installation of much greater power will be of interest. The Standard Motor Construction Company has recently made a proposition to furnish a double-acting gasoline engine of 1,200 horsepower, consisting of two units of 600 horsepower each, coupled together, to be installed in the torpedo boat *Mackenzie*. This machinery will weigh about 10 tons less than the present steam equipment of 850 indicated horsepower, and there will be a further saving of about 6 tons in the weight of fuel. The present machinery weighs 29 tons, so that it is at once apparent what a proportionally large saving in weight will result from the substitution of the gasoline equipment. This fact alone makes the proposition worthy of the most serious consideration, not so much for any improvement that will result to the *Mackenzie*, as for the experience that will be gained from such an installation in connection with future designs, where the possibilities for improvement in the boat as a whole are greater.

On the other hand, it is believed to be an open question whether a gasoline installation of this magnitude can be made sufficiently safe. The danger of destruction of the boat from explosion or fire from an enemy's shell is great, and may be considered by some sufficient to render the installation inadvisable. In order to overcome this as far as practicable, the gasoline tanks should be located low in the boat, and protected by light armor, and the gasoline piping also should be carefully protected from possible damage from shell fire.

DISCUSSION.

R. C. Monteagle.—Gasoline is dangerous, in spite of claims to the contrary. It may be ignited in the mouth of a can, and a blue flame will be the result. If there is no air in the can there will be no explosion, but under certain densities of vapor and certain relations between air and vapor an explosion would be sure to occur. A great danger is that from leaky joints. About the only way to obviate this would be by the use of double copper tanks and double copper pipes, both fitted with a minimum of joints.

J. F. Craig.—There would be no objection to carrying gasoline on deck in steel tanks. It would, however, be out of the question in general to put it below, largely on account of the insurance risks. The gasoline engine, as usually built, is single-acting, and is a very hardy piece of mechanism, the only parts which are delicate being the carbureter and the igniter.

No. 6.—High-Speed Motor Boats for Pleasure Use.

BY HENRY R. SUTPHEN.

ABSTRACT.

Several manufacturers are now prepared to deliver from stock, or upon short notice, 18 and 25-mile motor boats equipped with gasoline (petrol) marine engines for pleasure use. The first fast boats produced were designed particularly for racing, and developed speeds of from 24 to 27 statute miles per hour, the hulls being of light construction and the engines of minimum weight. From the experience in building the racing launch, the high-speed pleasure boat has been developed, which fills the demand that has long existed for a safe, seaworthy boat that could cover distances over the water in the shortest possible time.

While the principal development of the high-speed launches has been in the open type of boat, attention has lately been given to the cabin launch, affording still further protection, comforts and carrying capacity, combined with high speed. In a 40-foot by 8-foot beam cabin launch of unique design, the motor is placed forward, protected with hinging hood; controlling levers and steering wheel being located in the engine cockpit. The boat is handled and the engine controlled by one man. An open space covered by the cabin roof adjoins the engine compartment, separated by a glass wind shield; with a commodious cabin amidships, inclosed by plate glass windows, with buffet and toilet compartments. The scantlings and details of construction are light, but found to be substantial. The boat is equipped with a 6-cylinder, 75-horsepower engine, with which power a speed of 18.85 statute miles an hour has been obtained.

The possibilities of further development of the high-speed motor boat for pleasure use are limited only in details of hull

and engine construction, the aim being to design and build boats that best conform to the high-speed gasoline marine engine, which has made possible this new type of power boat.

No. 7.—Some Observations on Motor-Propelled Vessels, and Notes on the Bermuda Race.

BY WILLIAM B. STEARNS.

ABSTRACT.

There are several details wherein the general treatment of the design of motor-propelled vessels must differ from that for steamers. The reason for this is that, except in vessels designed for weight carrying, or for craft of very high speed, the designer of the motor vessel is troubled to know how to get rid of the excessive buoyancy, quickness of motion and general liveliness which result from the lightness of the propelling machinery and fuel. On a given length a fairly liberal beam is usually necessary to provide the accommodations required by most owners. Sufficient displacement is obtained with a very shoal body, and unless the weights are distributed in such a way as to offset it, there is a strong probability that the vessel will be very uncomfortable on account of quick rolling. This can be reduced, to a certain extent, by keeping down the area of the load-water plane, and placing some of the weight fairly high.

In the Bermuda race we had practically no opportunity to try the boats against a head sea. Both during the race and on the return trip all the strong breezes experienced came from abaft the beam; but on several other occasions I have been in craft of this sort in comparatively rough water, and have found them astonishingly good sea boats. If anything, the tendency is to recover too quickly after plunging into a sea. This is due, of course, to the extremely high proportion of reserve buoyancy to displacement, and results in one fault—a tendency to pound. On account of this it is not always an objection to put a certain amount of weight near the ends, on the same principle that I advocate spreading weights transversely. Also, I believe that the lines both forward and aft, but especially forward, of a light displacement motor-driven vessel, should be kept considerably finer than would be found necessary on a steamer of the same size. A comparatively minor matter, to cite another point of difference, is the rudder. I believe a motor vessel will generally require a larger rudder than a steamer. We found on the *Idaho* that it was difficult to meet her with sufficient quickness to avoid considerable deviation from the course when running before a sea, even with a rather large rudder area for her size.

It does not require a prophet to foresee that in the very near future owners of motor yachts will rebel at the cost of gasoline (petrol). Even now its expense is prohibitive for commercial use in high powers, and the building of gasoline yachts has undoubtedly been restricted by its cost. As alternatives we have kerosene and producer gas, made either from coal or heavy oils. There seems to be no difficulty in the operation of certain types of motors by kerosene, but in some instances of which I have known there have been decided drawbacks to its use. At the same time the reduction in expense, although amounting to nearly 50 percent as compared with gasoline, does not bring the operating cost as low as that of a good steam plant for a moderate sized vessel. Of the use of crude oils and distillates we have not had much experience in this part of the country, but on the Pacific coast, vessels of 150 feet and over, which are driven by engines using crude oil, are not uncommon. On the whole, the use of producer gas from coal seems to promise the best results, both for yachts and commercial vessels, although when expense is not an object gasoline will continue to be used. This will undoubtedly be the case with a great many small launches, all speed launches, submarines and vessels such as torpedo craft, which may be driven by motors in the future. For yachts, the updraft producer with hard coal will probably be employed, but the type to be used is at present a matter which concerns the engineer rather than the architect. There seems to be no reason why gas producers, substantially like those in operation on land, cannot be used successfully on ships, and in combination with an efficient motor they offer very great advantages over steam plants. With a good producer a thermal efficiency of 87 percent can be reached, and I understand that it is perfectly safe to count on 75 percent under ordinary service conditions of operation. The fuel consumption can be figured safely as half that of steam.

DISCUSSION.

A. C. Smith.—The *BM* dimension of the *Idaho*, as originally fitted, was 7 feet; that of the *Ailsa Craig* only 3 feet. The *GM* of the *Idaho* was reduced by careful attention to the stowage of weights, the gasoline and other weights being stowed well forward and well aft. The weights in the *Craig* were largely amidships. The ideal type would seem to be some sort of a compromise between these two boats.

F. L. Du Bosque.—The producer, as applied on shipboard, requires considerable space and weight, and gives off dangerous gases—gases which are poisonous for respiration.

E. A. Stevens.—It would appear that the only way to displace gasoline is by the development of some cheaper or better fuel as a substitute.

PAPERS READ FRIDAY MORNING.

No. 8. Two New Revenue Cutters for Special Purposes.

BY C. A. M'ALLISTER, ENGINEER-IN-CHIEF, U. S. R. C. S.

ABSTRACT.

Those familiar with conditions existing on the Pacific coast, with especial reference to the Northwestern part of the United States proper, are aware of the extreme hazards of wind, currents and fog encountered by navigators in that locality. The entrance to Puget Sound through the Straits of Juan de Fuca is particularly dangerous, as throughout at least half the year fogs and haze prevail, and at all times erratic currents exist which are but little understood even by men who navigate these waters constantly. Deep-water soundings may be obtained close inshore, so that not much dependence can be placed on the lead and line when vessels are headed in the straits. In the past half century nearly seven hundred lives have been lost in the immediate vicinity, to say nothing of millions in property. Numerous palliative schemes have been suggested, among them being international life-saving stations along the Vancouver coast. This, however, proved inadvisable, and, finally, after mature consideration, it was recommended that "a first-class ocean-going life-saving steamer or tug, officered and manned by the most skillful life-saving crew available, should be stationed at Neah Bay (which is within 5 miles of Cape Flattery and the entrance to the straits, and is the only available harbor in that vicinity), to be equipped with the best possible appliances of surf boats and lifeboats and with a wireless telegraph apparatus."

It is believed that the design of the life-saving vessel contemplates the furnishing of every known device of any practical value which can be of service in saving life at sea. Summarized, the special equipments of this vessel are as follows: Two self-bailing and self-righting lifeboats; life raft; line-throwing gun; breeches-buoy apparatus; complete equipment of life buoys and life preservers; wireless telegraphy; Ardois system for night signaling; additional searchlight; wrecking apparatus for pumping out vessels, and fire extinguishing apparatus.

Floating wrecks, or derelicts, as they are commonly termed, drifting aimlessly in the paths of ocean-going vessels, have been

a constant menace to searfaring men for years past. To the men on the bridge of a fast trans-Atlantic passenger steamer, the thought that at any moment they may crash into a half-submerged wreck and cause the loss of their vessel is anything but comforting. Other ships in their path at night are discernible by lights, or can be located by signals in fogs; even icebergs make their presence known by lowering temperatures, but the specter-like derelict gives no indications of its whereabouts. The danger of collision with these floating obstructions is known to all who travel by sea, yet until this time no systematic effort has ever been made to rid the ocean of these menaces to navigation.

The United States government, always foremost in any movement to promote the interests of humanity, has finally decided to be the pioneer in what is hoped will be an international system for removal of derelicts from the most frequented paths of ocean travel. To that end Congress recently passed a bill, appropriating $250,000 (£51,200), for the construction of a vessel to be used exclusively for derelict destroying.

DISCUSSION.

R. S. Riley.—The derelict destroyer ought to have towing machines if it is going to succeed in getting lumber-laden derelicts into a position where they can be broken up without danger of leaving floating wreckage in the paths of ships.

Spencer Miller.—A breeches buoy is a very good contrivance, and, although the passenger is almost certain to get very wet, and is sometimes brought ashore half drowned, or otherwise suffering from exposure, it is not on record that any life has ever yet been lost in this way, once the journey from the ship was started. In the United States alone, in 1906, no less than 189 passengers were carried ashore in this way. In the case of the *Berlin*, last February, it was attempted to rig up this device from a ship which proceeded outside the wreck. The sea was so high, however, that the lines snapped, and the device could not be operated at all. The present device for the life-saving vessel described consists of a common coast breeches buoy, with the addition of an automatic reel in the engine room. This reel will take in and pay out the rope as fast as the varying tension on the line calls for it.

No. 9.—Test on the Steamship Governor Cobb.

BY PROF. W. S. LELAND AND H. A. EVERETT.

(This paper will be found at page 21.)

DISCUSSION.

Andrew Fletcher.—The test was manifestly unfair, because apparently of inadequate and incomplete preparations. The curve of speed on revolutions per minute shows that the propeller lost efficiency just above 17 knots, which is at variance with the facts. In our tests of this ship she was run up to 19 knots without such loss of efficiency. On her run from New York to Boston with a green crew, she averaged for 14 hours 35 minutes a speed of 18.12 knots, and 459.3 revolutions per minute. In the present test the boiler pressure was only 128 pounds, in place of 150 pounds, designed, which must have had a marked effect on the economy. The figures again show an evaporation in the boiler of 10.65 pounds of water for each pound of coal. This must have been very remarkable coal.

D. W. Taylor.—The conditions must have been totally unsuited for speed, or else the log at high speeds was unreliable. The curve shows an increase of 2½ knots for an increase of 50 revolutions from 300 to 350, while the increase of 50 revolutions from 425 to 475 shows an increase of only ½ knot.

F. M. Wheeler.—It would appear that the extra vacuum used coal, and that the blower also used coal. These would have their effect upon the consumption per horsepower of the engines. Some years ago in the cruiser *New York* a test was made to determine the additional power required in the air pump for an addition of 1 inch to the vacuum, and at a figure like this the addition was very great.

No. 10.—Appliances for Manipulating Lifeboats on Sea-Going Vessels.

BY AXEL WELIN.

ABSTRACT.

The principal requirements of an ideal system of davits, such as they present themselves to me after several years of keen and careful study are: (1) The boat must, in all circumstances, and in every position, be under efficient control. (2) A moderate list of the ship must not prevent or appreciably retard the manipulation of the boat. (3) The mechanism should be of the simplest possible nature, and always "get-at-able." (4) The manner of manipulating the davits must be such as to preclude any necessity for expert training, and all possibility of confusion in cases of accident. (5) Cost, weight, and deck space occupied are all matters which must be taken into account, even if they do not come within the scope of the subject, when treated from a strict "life-saving" point of view.

Shipbuilders do not, as a rule, welcome deviations from orthodox designs; that deviations must ultimately come, I am nevertheless more than ever confident. At a time when scarcely a month passes without witnessing the birth of some new leviathan, each exceeding its forerunner in speed and passenger-bearing capacity, the compelling necessity for such vessels to be fully equipped with life-saving appliances of the highest order is a fact which cannot fail to thrust itself with an added force and conviction upon the observation of the most callous.

DISCUSSION.

Lewis Nixon.—When such improvements as the present come up for attention, they will be fitted whenever demanded by the owners. It is not usual, however, for the shipbuilder to go to this expense unless required.

Roland Allwork.—These davits simply put the boats over the side, but provide no special means for lowering them into the water. It would seem that this addition would make them much more valuable.

Frank E. Kirby.—This device has a large advantage over the usual davits in that it requires only one set of falls, that for lowering the boat. The usual device has an additional set for operating the davit. The proposition to store the boats on decks much nearer the water must commend itself to shipbuilders.

Axel Welin.—The pitch angle on the thread by which the davit is run out is just a little below the angle of repose. As a result, the boat will not run out by its own weight, unless it is operated by means of the crank. Lowering of the boat may be accomplished safely by means of brakes or winches, but in the present installations it has been desired to keep the mechanism as simple as possible. A winch, however, may be fitted if desired.

PAPERS READ FRIDAY AFTERNOON.

No. 11.—The Transportation of Refrigerated Meat to Panama.

BY ROLAND ALLWORK.

ABSTRACT.

This paper gives a description of what has been done in the way of transportation of refrigerated meats to Panama, for the use of the thousands of men located on the Isthmus and engaged in the construction of the Panama Canal. The fleet consisted of five steamers, only one of which was provided

with mechanical refrigeration. The system was the ammonia compression system, and, in the fitting out of three of the other four vessels, the same system was employed. The paper gives a very complete description of the installations fitted, and gives as well a log showing the operations of the plants.

Experience in both the fitting and the operation gave rise to recommendations of various sorts, it being found advisable, for instance, to use galvanized meat rails; to give a thin coat of graphite to whatever black pipe had to be used; and to line the refrigerating rooms with galvanized iron, it being found easier thus to keep them clean. The refrigerating machines fitted included one 5-ton plant and two of 7½ tons.

DISCUSSION.

Lewis Nixon.—The improvements and ingenuity shown in fitting up these vessels for their work have resulted in a paper, in which the author should be commended for the fine details and general completeness.

R. R. Row.—Cow hair may be recommended for insulation. This weighs about 13 pounds per cubic foot, and absolutely prevents all sweating, which would otherwise corrode the metal. It is more expensive than cork, but seems to do the work better.

No. 12.—Two Instances of Unusual Repairs to Vessels.

BY ASSISTANT NAVAL CONSTRUCTOR W. B. FERGUSON, JR.

ABSTRACT.

The collier *Nero* grounded about the 1st of August, 1906, off the Southeast Light, Block Island, and rolled back and forth a number of days on a stony bottom. The crew, movable stores, boats, etc., and about fifteen hundred tons of coal were taken ashore, and the wrecker had charge of the ship until she was finally floated and towed to New London, Conn., where the work was continued of removing coal and operating the wrecking pumps. On Aug. 20 the vessel was drawing 21 feet aft, and 18 feet 3 inches forward—her normal draft would have been about 11 feet aft and 9 feet forward.

An examination of the bottom after the vessel was docked showed the following conditions: The main keel was more or less bent and dented for its entire length; there were three large holes in the outer bottom plating, one at the turn of starboard bilge well forward, one at the turn of port bilge slightly forward of amidships, and one in the engine room through the port garboard strake. There were numerous smaller holes below turn of bilge. Many butts and seams had been started; many plates were bent and torn, and frames crushed in; numerous rivets were out or loose, and calking was generally started; the bilge keels were torn and portions hanging loose. There was buckling of floors and longitudinals in numerous places. The vessel was somewhat hogged, and bulkheads had leaked badly.

Temporary repairs were made by covering the worst holes and the indentations in their vicinity with spruce furring-off pieces, giving a smooth surface outside on which a temporary sheathing of 3 by 3-inch spruce was bolted. Elsewhere the leaks were stopped by calking and renewal of rivets.

The permanent repairs made provided for strength and watertightness, and while they did not put the vessel in her former condition, they were commensurate with the value of the remainder of the ship. Wherever the bottom plating required renewal, on account of large holes or torn plates, the frames, floor plates and longitudinals were also found to be in such poor condition that they had to be cut away and renewed. The small holes in the plating were patched locally. All sheared or loose rivets were replaced with larger rivets, after reaming the rivet holes. No reverse bars or inner bottom plating was renewed. Forward on the port side it was necessary to straighten the reverse bars in a few places. In a number of places dents were removed and frames straightened by heating them in place with annealing burners.

It was reported in April, 1907, from a preliminary examination of the planking of lightship No. 68, that several bolts in the underbody had been destroyed by galvanic action, which might be taken as an indication that serious deterioration of the fastenings of the vessel had taken place. Owing to the method of construction of the vessel, a good examination could not be made without removing the copper and wooden sheathing. The vessel was therefore docked in the New York navy yard for this purpose, and also in order to make necessary repairs; when the condition of the bottom was found to be much more serious than had been supposed, presenting an extraordinary case of the dangerous results of electrolysis and corrosion, resulting from using in the construction of the hull of a vessel metals which are electropositive and negative to each other.

In order to renew defective bolts, it was necessary to remove the water tanks, the cement covering the keel plates, and the coal bunker linings. Then the copper sheathing and oak sheathing were removed, and all the iron bolts and nuts securing the planking to the frames were replaced by naval brass bolts and nuts, the holes through frames being reamed out and ⅞-inch naval brass bolts—that is, ⅛ inch larger diameter than the original—fitted.

DISCUSSION.

F. L. Du Bosque.—A single sheathing of copper, fastened in the usual way, soon loses its value and the fastenings are wasted away. Muntz metal protects the bolts, but at once destroys the framing of the ship by corrosion. A suggested cure is the use of galvanized iron for sheathing in place of copper. It is not so durable, having to be replaced every sixteen or eighteen months, as in the case of zinc, while copper will last two or three years, when obtained of the grades now generally in the market. The cost, however, is less, notwithstanding the greater frequency of renewal, and the corrosive effects with regard to the hull are almost entirely eliminated.

J. A. Furer.—The use of composition sheathing in the case of a light vessel is not so much to prevent fouling of the bottom, which is unimportant with these vessels, but to protect the hull.

William McEntee.—The cruiser *New Orleans* is sheathed with teak on the outside of ⅜-inch steel plating. A composition casting for a sea valve has been run through the hull in a number of places, and is connected directly to the steel of the inner and outer bottom. In spite of the direct contact of the metals, however, no corrosion seems to have taken place.

W. J. Baxter.—The frames of the light vessel in question were not injured in any way. With the present method of fitting copper sheathing it is possible to watch for deterioration and to remedy it when it comes. With galvanized iron nothing can be seen, and a serious accident might result from a comparatively light blow on a part so badly corroded beneath the surface as to be spongy.

No. 13.—Wooden Sailing Ships.

BY B. B. CROWNINSHIELD.

ABSTRACT.

Although there were French and English scientists as early as the middle of the eighteenth century who made accurate calculations of displacement and stability, vessel models were but little affected by these studies, and, until the latter part of the last century, shipbuilding still continued to be an "art" and a "mystery." To-day, the steel vessels are minutely

figured, and accurate drawings are furnished for every part of the structure; each man does his allotted part, and the ship, as it were, is apparently built by draftsmen and boilermakers.

The men who turned out the wooden tonnage usually constructed the entire hull, frame, plank, ceiling, decks and joiner work. They were usually calkers, painters, spar makers, and riggers as well as carpenters; men of wonderful resource, self-reliant and skilful. They had been trained by long experience and by the traditions of their forefathers; and had learned by many failures and disasters what to avoid. Progress had been attained almost wholly by development. The model of each vessel was derived from, and was, in fact, the natural growth of, those immediately preceding it. Anything radically different was quite properly discouraged, there being no thorough workable knowledge of the natural laws of stability, flotation, or application of the law of the composition and resolution of forces, as applied to the problem of propulsion by sails.

It is unlikely that any more large wood square-riggers will be built for long voyages, a steel hull having many advantages. The hull can be subdivided by the bulkheads and a double bottom, so as to make a vessel practically unsinkable, and in case of fire it can be kept under better control than in a wooden ship. And, most important of all, the steel hull can be made absolutely strong and rigid and perfectly tight, the shell plating being practically continuous, and in a sense sufficient to hold the entire structure without the frames, and in marked contrast to the plank of the wood vessel, where each piece is attached only to the frames, which in turn are composed of comparatively short pieces.

The construction of wooden vessels has varied but slightly during historic times. White oak has always been used when it was procurable for keel, frames, ceiling, plank and beams, in fact, for the whole structure except the deck and deck erections, where pine has been almost always employed. Recently mahogany and teak have been imported from the tropics for all deck erections, and frequently entire decks are now made of this material. Oak has become scarce, and the price has increased enormously in the last one hundred years. This has led to the substitution of other woods for plank, beams and ceiling, and even for the frames. Georgia pine is now universally used for plank, ceiling, keelsons and beams in the large cargo vessels built in New England. In New Brunswick and Nova Scotia many successful schooners and even ships have been constructed entirely of spruce, but for the largest vessels as now built, spruce would not be suitable, because of the comparatively small size of the timber.

DISCUSSION.

A. J. Du Bois.—A number of fast sailing vessels designed by Steers might have been mentioned in the article, these including the famous *America;* the frigate *Niagara,* which laid the first ocean cable, and the sloop *Lancaster.* The latter was the most beautiful design ever included in the United States navy, and was known as the "naval yacht."

E. A. Stevens.—The yacht *Sappho* has a recorded speed of more than 16 knots for several hours. She lowered the sailing record between New York and Great Britain. It may be remarked in general, however, that a vessel built for extremely high speed for a short distance is usually the result of sacrificing qualities making for the highest average speed in a long voyage.

W. F. Palmer.—The interests with which I am connected maintain a fleet of fifteen or sixteen fore-and-aft sailing vessels in the coaling business. This year will be completed with a return of about 23 percent in dividends on the original cost of the fleet. We submit that no line of steamers in the world will show such a return. Sailing ships have been developed into their present form as the result of centuries of evolution, and present very little differences in general characteristics, where designed for the same sort of work. Steel and steam vessels even to-day are full of crudities, and are not nearly so well standardized or so adequately designed for their purpose as are the sailing vessels. Our ships are amply secured against deterioration and decay by the provision in many cases of three times the amount of timber really called for by necessities of strength.

Vessels which make fast runs are not necessarily dividend payers, and when it comes to a question of the vessel best suited for her purpose, that one which will pay the most dividends must be awarded the palm. At present, sailing vessels can compete on more than equal terms with steamers in the coastwise coaling trade. If the steam colliers could be assured of immediate service without delays, the sailing vessel could not compete with them, but the very high cost of upkeep of the steamers while waiting their turns to take on or discharge cargo entirely kills all chance of highly successful competition with the more economical vessel propelled by the winds.

F. L. Du Bosque.—It might be mentioned in this connection that more than nine-tenths of all the coal handled on the coasts is carried by steam-driven vessels. The sailing vessel has to wait for a wind, and sometimes for maneuvering into position where she can be taken care of at the docks.

F. T. Bowles.—The wooden schooner is considered by some to be a weight around the neck of New England. The methods employed in the transaction of business by means of these vessels are as antiquated as the Constitution.

No. 14.—Some Early History Regarding the Double-Turreted Monitors Miantonomoh and Class.

BY WILLIAM T. POWELL.

ABSTRACT.

Notwithstanding the absence to-day of advocates of the double-turreted monitor type of vessel, it may be of interest to recall some early history regarding the *Miantonomoh* and her three sister vessels. I investigated the range of stability, and the results given are the first complete curves, so far as I know, in this country; nothing of this kind was in evidence when these vessels were being designed, though eagerly sought for at that time. There was not a planimeter available; therefore the work was tedious and long.

The first *Miantonomoh* and her three sister vessels were all built of white oak and yellow pine. In the course of years they became rotten and were broken up or sold. It was considered necessary as well as cheaper to rebuild them of iron rather than of wood, and in this connection it was the original intention to utilize the old side and deck armor, also the turrets and guns, and, in fact, all that could be used with advantage and economy. The experiments abroad in the meanwhile, however, demonstrated the necessity of making some changes and improvements in their offensive and defensive qualities, and much delay in their completion was the result.

The exact size and type of turrets and guns remained unsettled for some time. The question also as to whether it was advisable or not to build a house or superstructure on the deck between the turrets to accommodate the officers was undecided for quite a time. Therefore, in view of these uncertainties, I omitted in the calculations the turrets and house, also the armored stack and ventilator, in the stability work. Under such circumstances it was also impracticable to determine with certainty the exact vertical location of the center of gravity of the whole complete vessel. These conditions, however, did not prevent the assumption of the center

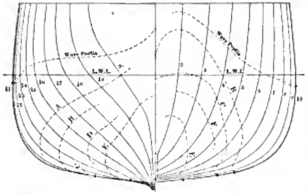
of gravity in several places, as shown on the curves. And it was hoped on final completion that the vessel would be heeled. This would have enabled one to determine the actual curve in short order; but this opportunity never occurred to me.

An Experimental Investigation of Stream Lines Around Ships' Models.*

BY D. W. TAYLOR, NAVAL CONSTRUCTOR, U. S. N.

One of the investigations carried on at the United States experimental model basin during the past year has been into the question of stream lines or lines of flow around ships' models. These flow lines must be practically the same for ship and model, and a knowledge of them is important in determining the locations of bilge keels, docking keels, etc.

Several different methods of investigation were tried, all, however, upon the same principle. The details of the method finally adopted as the best are due largely to Mr. E. P. Lesley, who was detailed on this work for some time. The surface of the wooden model is coated on one side with hot glue applied with a brush. Before this sets it is painted over with a strong solution in water of sesqui-chloride of iron (Fe_2Cl_6). It is allowed at least 24 hours to set and harden. The model is then put into the water and towed at the speed corresponding to that of the full-sized ship.



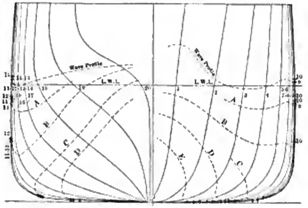
BODY PLAN OF UNITED STATES PROTECTED CRUISER SAN FRANCISCO.

To trace a stream line, a small hole is bored through from inside or, in the case of extremities, from the opposite side of the deadwood, and a strong solution of pyrogallic acid [$C_6H_3(OH)_3$] is injected through the hole while the model is under way. A solution containing 10 ounces of acid to a gallon of water, which was about the strongest solution used, has a specific gravity of 1.03 This is instantly largely diluted by the water as it passes through the hole in the model, and flows aft as part of the water. The particles of pyrogallic acid which come in contact with the coating of chloride of iron combine to form ink. The result is a dark streak or smudge on the surface of the model, which widens as it passes aft, and is of such a nature that its center line, which is taken as the stream line past the hole, can be located with a good deal of accuracy—say, within a quarter of an inch for a distance of from 2 to 4 feet abaft the hole. After each run the model is lifted from the water, the stream line located as far as possible and marked, and a new hole bored at the after portion of it for the next run. The process is not a rapid one, even when several stream lines are being carried aft at once, and it takes about a day to determine half a dozen lines of flow from stem to stern of a good-sized model.

The wave profile against the side can be determined similarly by dropping a little acid into the water close to the side; but, since ripples cause the water to wet the side above the true mean surface, the wave profile thus determined is apt to be from ⅛ to ¼ inch above the true mean wave surface. The wave shape, however, is quite accurately given.

The table gives the dimensions and data for seven ships whose models have had their stream lines determined as described above, and the figures give the stream lines past the models. Each line is distinguished by a letter, which is necessary, since some lines extend from stem to stern, while others were traced for short distances only.

Each of the seven vessels is of a different type, except the *San Francisco* and *Baltimore*, and their speeds in proportion to their lengths vary, as indicated by the varying speeds of the 20-foot models. The *San Francisco* and *Baltimore* are old



BODY PLAN OF UNBUILT COLLIER, UNITED STATES NAVY.

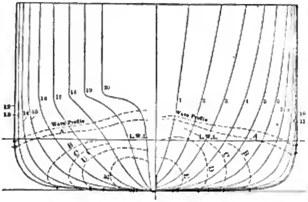
protected cruisers of the United States navy. The collier is a model of a collier designed for the navy, but not built. The *Sotoyomo* is a navy tug, which has great beam in proportion to length. Number 5 represents a shallow draft river steamer, which has great beam in proportion to its draft. Number 6 is a very full vessel driven at low speed and having a parallel middle body. Number 7 does not represent an actual vessel, being a model with a swollen amidship section.

* Read before the Society of Naval Architects and Marine Engineers, New York, Nov. 21, 1907.

No.	Vessel.	Ship.					Model.				
		Length on L. W. L. Feet.	Breadth on L. W. L. Feet.	Mean Draft. Feet.	Displacement in Salt Water in Tons.	Speed in Knots.	Length on L. W. L. Feet.	Breadth on L. W. L. Feet.	Mean Draft. Feet.	Displacement in Fresh Water in Pounds.	Speed in Knots.
1	*San Francisco*..............	310.0	48.76	18.94	4,098	19.52	19.900	3.146	1.222	2,398	5.00
2	*Baltimore*..................	327.5	48.93	20.08	4,570	20.10	20.000	2.988	1.226	2,267	4.97
3	Collier......................	460.0	61.70	25.82	15,000	15.00	19.745	2.648	1.108	2,582	3.11
4	*Sotoyomo*...................	94.64	21.03	9.16	258	10.31–5.50	19.555	4.346	1.893	4,955	4.69–2.50
5	Shoal draft river steamer...	257.0	30.58	5.54	661.5	19.00	20.000	2.380	0.431	679	5.30
6	Great Lakes ore steamer....	540.0	55.57	19.50	14,505	10.42	20.000	2.058	0.722	1,605	2.05
7	Special Type................	490.25	81.70	22.40	14,750	19.00	20.546	3.424	0.939	2,361	3.89

An examination of the figures discloses at once a condition of affairs very different from what is often supposed to be the case. The general assumption has been, I believe, that the water would part more or less horizontally forward, follow a diagonal amidships, and aft would flow up from below. The figures show, however, that the water forward does not flow away horizontally, but insists upon passing under the vessel, and by no means along a diagonal. Consider, for instance, the line B in Fig. 1. On station 2 this line is nearly 40 percent of the draft of the ship above the original load waterline. Yet amidships this line has found its way clean under the bottom, following practically a vertical line for a respectable portion of its course. This general phenomenon is found in every case—even in the case of the abnormal type of model number 7, which was tested with the idea that if the water would part horizontally for any type of model, it would do so for the model number 7. It is seen, however, that even here the water finds its way under the bottom of the vessel. The figures, with one exception, refer to one speed in each case, being about the maximum speed attained by the vessel, or which might be expected from it. The *Sotoyomo* model, however, was tried at two speeds, one corresponding to the full speed of the ship and the other corresponding to a very low speed. The stream lines are seen to be not very different, the differences which manifest themselves being clearly explicable by a consideration of the difference in surface disturbance.

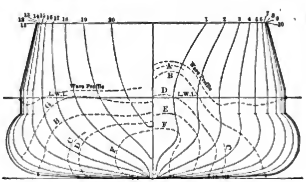
Careful investigation of the figures will show that the waves on the surface apparently influence the stream lines to a remarkable depth. In a number of cases it will be found, on following up the sections to the surface, that apparent eccentricities in the stream lines correspond to hollows in the wave profile.



BODY PLAN OF FAST, SHALLOW-DRAFT RIVER STEAMER.

In the lake steamer, a vessel with a long parallel middle body, the lines of flow over this parallel middle body are not parallel to the axis. Spots are given showing where each flow line cuts the various stations of the parallel middle body. It is seen that line E—the inner line—steadily works outward as it passes aft along the parallel body. The lines above the turn of the bilge indicate wave motion, although, as it happened for this model, with its low speed, the wave line was practically level over the forward portion of the parallel body. Model 3 of the collier, which is rather flat, has almost a parallel middle body and shows somewhat the same features.

The general features of the stream lines around models have been confirmed by a number of experiments with other models, and, I think, indicate that the commonly accepted notion as to the flow of water around the fore body of a ship is erroneous. Indeed, upon reflection, it is difficult to see how it would be mechanically possible for the water to flow out horizontally from the fore body and up vertically around the after body. Were this the motion, how could water be gotten



BODY PLAN OF SPECIAL FORM, MODEL NUMBER SEVEN.

down below to take the place of that which flows up around the after body? If, however, we consider that the water flows down forward, passes under the ship and then comes up again, we have a motion which is evidently mechanically possible.

It may be remarked, in conclusion, that these stream lines, experimentally determined around models, show, broadly speaking, a remarkably close agreement with theoretical stream lines past submerged solids.

Test on the Steamship Governor Cobb.*

BY PROF. W. S. LELAND AND H. A. EVERETT.

The test on the steamship *Governor Cobb*, of the Eastern Steamship Company, was run on the regular trip from Boston to St. John, via Portland and Lubec. Observations began on passing Boston Light, and were continued for 26 hours: for the boiler test continuously; for the engine test at favorable times. All observations were plotted, which presents an interesting study of the results, and makes simultaneous readings possible with a limited corps of observers. The close agreement of these curves is a good check on the accuracy of the observations.

The horsepower was determined by means of the Denny and Johnson torsion meter belonging to the United States ship *Chester*, which was loaned by the Navy Department. The torsion meter was set up in the engineering laboratory, and a thorough working knowledge obtained by the use of experimental apparatus, before installing the meter on board. Thirty-six feet on the side shafts, and 49 on the center shaft between inductors, was the greatest length obtainable, which gave a meter reading of about 0.50 and 0.73, respectively, at full power.

In computing the horsepower, 1.506, based on an assumed torsional modulus of elasticity of 11,600,000, was used for the constant K in the formula:

$$\text{H. P.} = \frac{Kd^4rR}{CL}$$

in which d = diameter of shaft in inches ($6\frac{1}{8}$); r = torsion meter reading; R = revolutions per minute; C = inductor constant (12.5); L = length of shaft in feet between inductors.

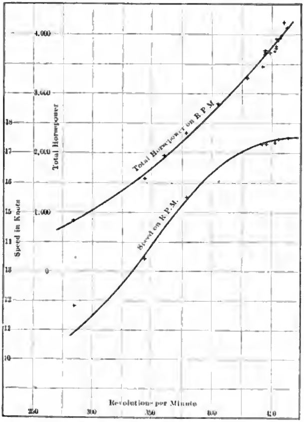
The water consumption was measured by a hot-water meter loaned by the Hersey Manufacturing Company, of South Boston. It was installed in the suction line between the hot well and the feed pump, and gave exceedingly satisfactory results. This meter was later calibrated under similar conditions. The plot of meter readings was struck in as a straight line, showing practically a uniform rate of consumption, no point varying from the line by a quantity greater than 1 percent of the total.

The steam for all auxiliary purposes was passed through the two auxiliary lines, one on each side of the vessel, and the

* Read before the Society of Naval Architects and Marine Engineers, New York, November 22, 1907.

quantity measured by its flow through orifices. A thin steel plate having a hole 1⅝ inches in diameter was inserted in each auxiliary line between two flanges near the boiler. Pressures were read simultaneously at both orifices, and at no time showed a variation of over a pound after making the proper gage corrections. The orifice was afterwards set up in the laboratory, and its coefficient carefully determined by actually weighing the condensed steam under conditions similar to those on the boat.

Several buckets of coal were weighed, and their average, which varied only 10 pounds from either maximum or minimum, multiplied by the number of buckets, was taken as the coal consumption. The plot of coal consumption, like that of the water, is a perfectly straight line, showing a uniform rate.



SPEED AND HORSEPOWER PLOTTED ON REVOLUTIONS PER MINUTE.

The run from Boston to Portland was largely consumed in a progressive trial, the speed being taken by a stop-watch and a McGray electric log towed from the end of a boom well clear of the wake. The log had previously been calibrated by towing over the measured mile. Results of speed and power are shown in the curves.

The best run was made at full speed between Portland and Lubec, under the most favorable conditions of weather and sea. All observations were taken at 10-minute intervals, excepting the coal, which was recorded every 15 minutes. An attempt was made to determine the quality of steam, but as there were objections to tapping the main pipe, a sample was taken from the drip connection, which showed 2.5 percent of moisture, which is more than would be obtained from a fair sample.

It may be of interest to compare the following tabulated results with similar results obtained from a test on the steamship *Nantucket*, of the Merchants' & Miners' Transportation Company:

Results of Test

	Nantucket	*Governor Cobb*
Date of test	Feb. 7, 1904	April 18, 1907
Duration of test—boiler	20½ hrs	8 hrs.
Duration of test—engine	20½ hrs.	4 hrs.
Boiler pressure (average gage)	147.3 lbs.	128 lbs.
Quality of steam (sampled at drip)	98.8	97.3
Barometer	14.7 lbs.	14.7 lbs.
Temperature of air pump discharge	....	110° F.
Temperature of feed water	200.4° F.	213° F.
Kind of coal used	Georges Creek	Cape Breton
Moisture in coal	2%	1.9%
Ash and clinker in coal	7.6%	6.8%
Draft at blowers	Natural	2.1 inches
Number of boilers (single-ended Scotch)	4	6
Total grate surface	320 sq. ft.	323 sq. ft.
Total heating surface, approximately	10,150 sq. ft.	12,000 sq. ft.
Ratio, heating to grate	31.7	37.2
Coal fired per hour	5,135 lbs.	8,050 lbs.
Water fed per hour (average during engine test)	45,844 lbs.	85,710 lbs.
Coal burned per square foot grate surface	16 lbs.	24.64 lbs.
Maximum revolutions	....	p. 475, s. 460 c. 440
Corresponding total shaft horsepower	....	4,100
Average revolutions	74.05	447
Average total horsepower	2,362	3,747
Steam for auxiliaries	....	38,360 lbs.
Steam per I.H.P. per hour, total	19.41 lbs.	....
Steam per brake horsepower per hour, total	....	22.87 lbs
Propelling machinery only	....	19.74 lbs.
Speed (average) in knots	15.00	17.21
Type of engine	Reciprocating	Turbine
Vacuum in inches	25	27

DIMENSIONS

Length between perpendiculars	274 ft.	290 ft.
Beam molded	42 ft.	51 ft.
Draft	15 ft.	14 ft.
Displacement	2,700 tons	......

The Merchant Marine of Japan.

The annual appropriation for promoting shipping and aiding lines of the merchant marine for the fiscal year ended March 31 last (subsidy) was $3,526,559 (£724,660), as for several preceding years. The appropriation for aiding shipbuilding was $399,250 (£82,040). For the current fiscal year, and for several succeeding years, additional subsidies have been guaranteed, amounting to $784,136 (£161,129) per annum, more than half of which is for lines to China.

The Japanese merchant marine in 1880 amounted to 63,486 gross tons; in 1890, the figure was 157,365 tons, or a gain of 148 percent. By 1900 the tonnage had risen to 840,632 tons, or a further gain of 434 percent. In the middle of 1906 the figure was 1,309,579 gross tons. This has been further increased since that date, there being on December 31, 1906, 1,446 steamships, aggregating 1,034,634 tons, or an average of 715. In addition to these, there were 4,044 sailing vessels of foreign model, amounting to 346,260 gross tons, or an average of 86 tons. This makes a total of 1,380,894 tons.

Of the steamships, 21 exceed 6,000 tons, and the number of large vessels is rapidly increasing. The dockyards of Nagasaki, Kobe and Uraga are very busy, having 60,000 tons on the stocks, and 50,000 tons more in prospect. Of the new steamers, six of 8,000 tons each are building for the Nippon Yusen Kaisha, and it is stated that a regular line between Japan and New York by way of Suez is to be established.

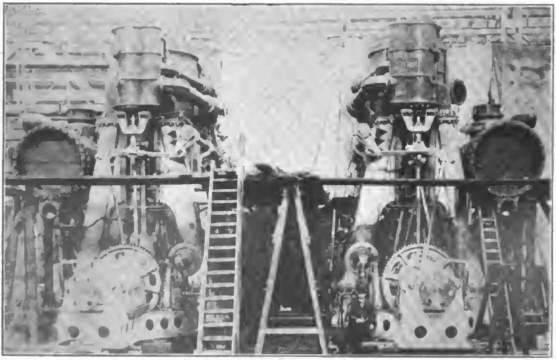
THE HAMBURG-AMERICAN STEAMER KRONPRINZESSIN CECILIE.

BY F. C. GUENTHER.

THE PROPELLING MACHINERY.

There are two main engines of the four-cylinder, vertical, inverted, direct-acting, quadruple expansion type, balanced according to the Schlick system, and each capable of developing about 3,035 indicated horsepower at 79 revolutions per minute, and a steam pressure of 214 pounds per square inch. The sequence of the cylinders, beginning forward, is high-pressure, second intermediate-pressure, low-pressure, and first intermediate-pressure, with, respectively, 23⅝, 50 3/16, 73 13/16, 34 7/16 inches diameter, and a common stroke of 53 15/16 inches.

The cranks follow each other in the regular order of size of cylinders, the high-pressure being followed by the first intermediate, the second intermediate, and then the low-pressure. On account of balancing, these cranks are not at right angles, the angle between the high-pressure and first intermediate being about 65 degrees. Between the first and second intermediate cylinders is an angle of about 95 degrees; between the second intermediate and the low-pressure, 105 degrees; and between the low-pressure and the high, again, 95 degrees.



PROPELLING ENGINES OF KRONPRINZESSIN CECILIE, ERECTED IN BUILDERS' SHOP.

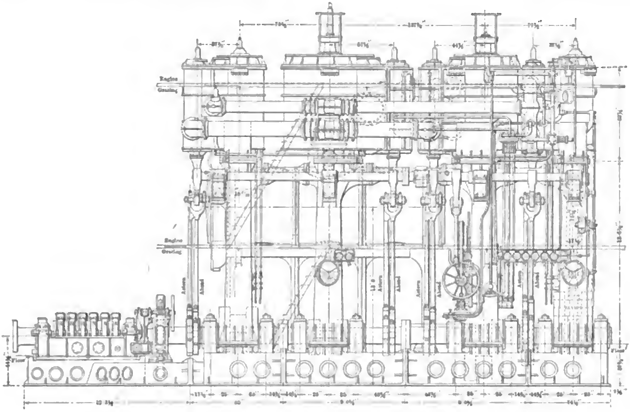
The high-pressure and the first intermediate cylinders have each one piston valve, with mean diameters, respectively 10⅛ and 17⅛ inches. The two larger cylinders have flat double-ported slide valves. The valve stems are in all cases of a diameter of 4⅛ inches, while the piston rods have each a diameter of 6⅝ inches. The two large cylinders have tailrods 4 7/16 inches in diameter. All valves are operated by Stephenson link motion from eccentrics, and can be worked by both steam and manual power. The valve strokes are, respectively, 7⅝ and 8¼ inches, for the piston and slide valves.

The main engines are in a single engine room without center line bulkhead, the starting platforms being conveniently located between the engines, with ample space for the engine crew to work in. The cylinders are safely bolted together, but there is no rigid fastening between them, thus allowing fore-and-aft play for expansion. Each of them is fitted with safety valves in the bottom and cover. They are supported by hollow cast iron box columns, and these, in the neighborhood of the engineers' platforms, are utilized for oil storage and provided with taps and pipes for filling them, and for drawing off oil as needed. All stuffing-box packings of the main engines, the pistons and the valve rods are metallic packings of the United Kingdom type, whereas all piston rods, pistons and slide rods of the auxiliary engines, winches, etc., are provided with Garlock (Palmyra, N. Y.) packing.

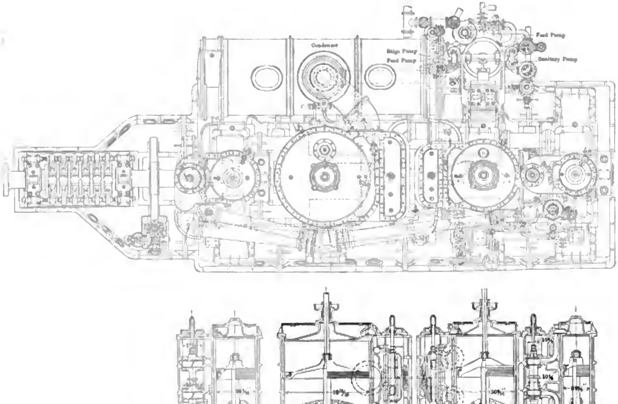
The main steam pipe has a diameter of 8¼ inches. The pipe carrying steam from the high-pressure to the first intermediate cylinder is 9 7/16 inches in diameter. The pipe next in order has a diameter of 13 inches, which is also the diameter of each of the two pipes carrying steam from the second intermediate to the low-pressure cylinder. The exhaust pipe has a diameter of 23¼ inches.

The shafting, which is made of best steel, has a tensile strength of 25.4 to 29.4 tons per square inch, and an elongation of 20 to 25 percent. The crankshaft diameter is 14 13/16 inches, thrust shaft 14 13/16 inches, line shaft 14 inches, and propeller shaft 15 3/16 inches. The flange couplings are 28 inches in diameter and 4⅛ inches thick. The crank pins are 15 3/16 inches in diameter.

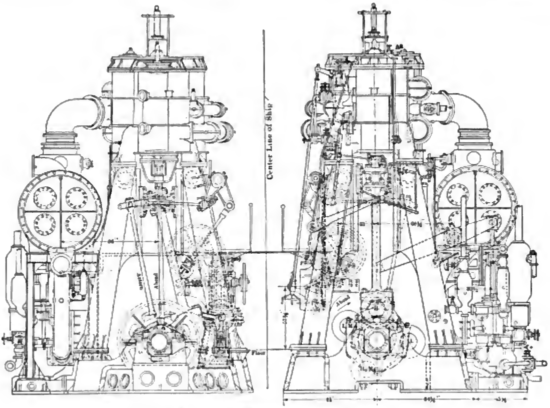
The two propellers, which are four-bladed, of the built-up type, turn outboard when going ahead. They are of manganese bronze, and have a diameter of 17 feet ¾ inch, and a pitch of 20 feet 4⅛ inches, the pitch ratio being 1.192, as set. This corresponds with point *A* in the drawing of blade setting. When the blade is set at *B*, the pitch is 18 feet 8⅛ inches, and the pitch ratio is 1.096; similarly, the pitch becomes 22 feet 3¾ inches, and the ratio 1.308, when the blade is set at *C*. These



ELEVATION OF THE PORT ENGINE AND THRUST BEARING FROM THE INBOARD SIDE.



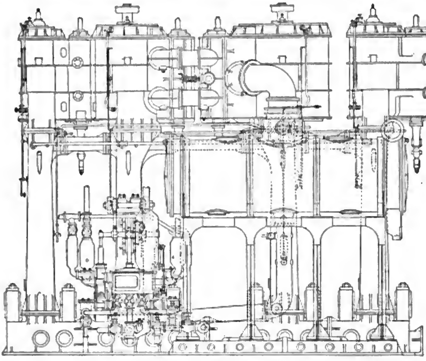
PLAN OF ONE OF THE MAIN ENGINES, AND SECTIONS THROUGH THE CYLINDERS AND VALVE CHESTS.



END VIEWS OF THE MAIN ENGINES, ONE FROM FORWARD, THE OTHER FROM AFT.

points are, respectively, the centers of the studs joining the propeller blades to the boss, and are located at intervals of 7/16 inch.

The projected surface of each propeller is 59.2 square feet, the developed surface 85.23 square feet, and the ratio of projected area to disk area 0.26. The hub, which is made of cast steel, has a diameter of 3 feet 11 11/16 inches, and is lined with zinc plates as a precaution against corrosion. The propeller blades are pitched aft, the axis of the blade at the tip being 17¾ inches aft of the axis of the propeller as a whole. The propeller shaft enters a conical seating in the hub, having a diameter at the forward end of 15½ inches, and at the after end of 12½

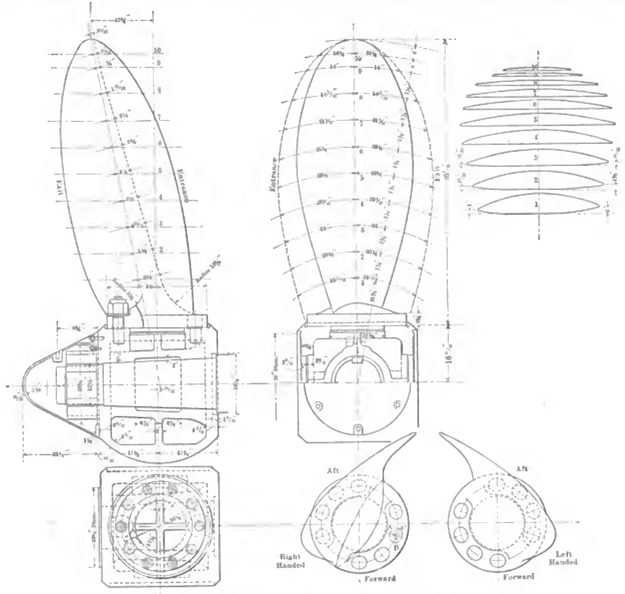


BACK ELEVATION OF THE PORT PROPELLING ENGINE.

inches. This conical portion has a length of 35 inches. A cap, covering the end of the shaft, protects the nut which holds the propeller in position. Each blade is fastened to the hub by means of four studs.

THE BOILERS.

Three double and one single-ended boilers of the cylindrical type, working at a pressure of 214 pounds per square inch, are located in one boiler room, and have a single funnel. There are three furnaces at each end of the double-ended boilers, and at the front of the single-ended one, making a total of twenty-one fires. The furnaces have internal and maximum diameters of 3 feet 9¼ inches and 4 feet 1¼ inches. The thickness is ¾ inch. The grates are 5 feet 5 inches in length, the grate surface for each double-ended boiler being 128.1 square feet, while the heating surface in each of these boilers figures out at 5,382 square feet, or a ratio of 42 to 1. The grate surface of the single-ended boiler is 64.6 square feet, and the heating surface 2,152 square feet, which makes an aggregate grate surface of 448.9 square feet, and a total heating surface of 18,298 square feet, or 40.7 to 1 of grate.



LAYOUT OF ONE OF THE SCREW PROPELLERS, WITH DETAILS OF HUB AND BLADES.

The double-ended boilers have a length over the ends of 20 feet 5½ inches and are made in three courses, two being outside and one inside. The outside diameter is 15 feet 10 inches, while the thickness of the plates is 1.6 inches. Each boiler contains three Morison suspension furnaces in each end, with a separate combustion chamber for each pair of furnaces opposite each other. The length of tubes between tube sheets is 7 feet 10½ inches, and they are spaced 4 inches apart in each direction. Each end of each double-ended boiler contains 414 tubes, of which 184 are stay-tubes and 230 are ordinary tubes. All have an outside diameter of 2¾ inches, with a thickness of 0.315 inch for the stay-tubes, and 0.1575 inch for the others. The front tube sheets have a thickness of 1.06 inches, while the back tube sheets are 1.02 inches thick.

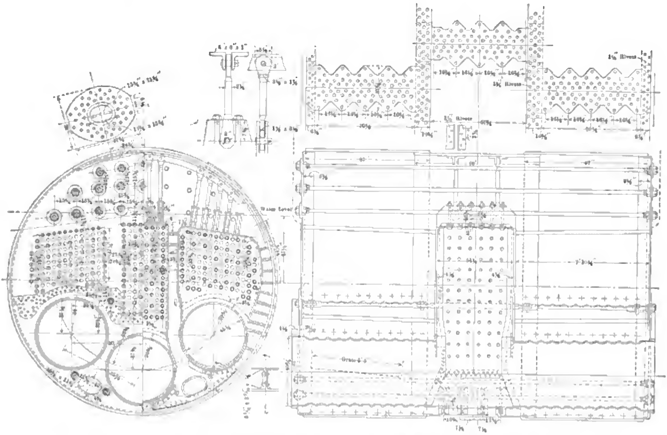
The tops of the combustion chambers, ⅝ inch thick, are supported by the usual bridge girder, there being four on the central chamber and five on each of the side chambers. Each carries six supporting bolts. Each of these girders, with the exception of the one in each case nearest the shell in the side combustion chambers, is supported in turn by two sling stays 2½ inches in diameter, and carried each on a continuous pair

of double angles 6 by 6 by 1 inches, riveted to the shell. The spacing of the screw stay-bolts in the combustion chambers is 7½ inches in each direction. These bolts are 1¾ inches in diameter.

Above the combustion chambers are twenty-one through stays, of which fourteen have each a diameter of 2⅞ inches and are provided with washers 10⅝ inches in diameter, while the others have a diameter of 2½ inches and have 10¼-inch washers. In the lower part of the boiler are six stays of the latter size, of which four are through stays, while the other two, passing between the combustion chambers, are made up of three sections swiveled together.

Each course of the boiler is made of a single plate, with a butt joint and double butt straps, the latter having a thickness of 1¼ inches. The strength of the outer courses in the boiler shell has been computed as 90 percent of the uncut sheet, and the inner course is given as 88.15 percent, with a thickness a trifle greater than the outer. The riveting has been done so completely as to furnish a rivet strength in excess of that of the unbroken shell by about 25 percent. The shell steel has been subjected to tests which show a tensile strength of 66,850 pounds per square inch, with an extension of 20 percent in 8 inches. The remaining plates show a strength of about 60,000 pounds per square inch, with an extension of 25 percent. The rivet material shows a strength of 62,500 pounds per square inch, with an extension of 20 percent. The plates are of Siemens-Martin mild steel, and the riveting, wherever possible, was done by hydraulic process.

The funnel, which has a circular section, consists of an inner and an outer tube, with sufficient air space between them, the diameters being 10 feet 2¼ inches and 12 feet 9¾ inches, respectively. Howden's forced draft is used, and two ventilators of 2 feet 11½ inches in diameter are provided for each fire side in the boiler room.



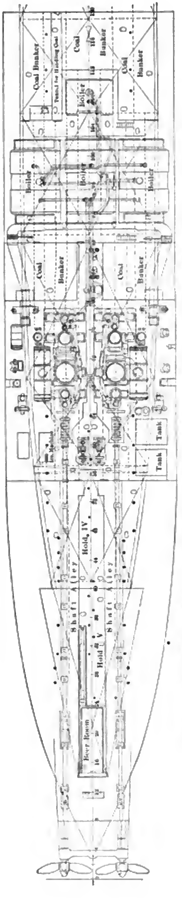
SECTIONS THROUGH ONE OF THE DOUBLE-ENDED BOILERS, WITH DETAILS OF RIVETING, MANHOLES AND SLING STAYS.

THE AUXILIARY MACHINERY.

The two main condensers have cooling surfaces amounting to 4,413 square feet each, while the auxiliary condenser has a cooling surface of 861 square feet. The cooling pipes, of the Everrett system, are of brass, tinned inside and outside, with a diameter of ¾ inch. The air pumps, of Edwards type, measure 23⅝ inches in diameter, with a stroke of 26 9/16 inches. The pump barrel is a bronze casting ¾ inch thick, the piston rod is of Parsons manganese bronze, and all the valves are of Kinghorn make. Each main condenser is fitted with one circulating pump of 150 revolutions per minute, of sufficient capacity to deliver the cooling water required for both engines when working with full steam.

Two feed-pumps for each engine are fitted, to be used when needed for boiler feed; they consist in all their parts of bronze, and have a plunger of 4 inches diameter, the stroke being 26 9/16 inches. There are fitted two single-acting bilge pumps, and two pumps for sanitary purposes of the same stroke as the feed pumps, and with cylinders 5 inches in diameter. The pump barrel of the bilge pumps is of iron and the plunger of brass.

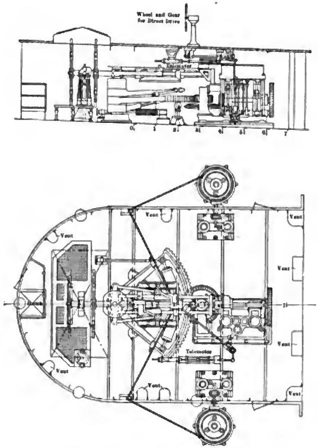
Besides these are two evaporator pumps 2 by 11¾ inches; one vertical ballast duplex pump 10 and 11 by 12 inches; two G. & J. Weir (Cathcart, Glasgow) pumps, each with a capacity of 50 tons per hour; and two duplex steam pumps 6 and 4 by 6 inches, which are used to draw drinking water, either from the tanks of the double bottom into a tank



THE PROPELLING MACHINERY LAYOUT OF THE SHIP COVERS, ALTOGETHER, 275 FEET, INCLUDING BOILERS, ENGINES, PROPELLERS AND COAL BUNKERS.

arranged in the engine room, or directly into a tank on the promenade deck. In addition to these pumps there is a circulating pump for the auxiliary condenser, of the same construction as the main circulating pumps, worked at 200 revolutions per minute.

The two starting engines have each two cylinders of 5⅛ inches diameter, with a stroke of 5⅛ inches. The turning engines have each one cylinder 6 by 4¾ inches. The steam steering engine, from Caldwell & Company, has cylinders of 12 inches in diameter, with a stroke of 12 inches. Among other auxiliary engines there are one for the anchors; eight cargo winches, four 7 by 12 inches and four 6 by 10 inches;



ELEVATION AND PLAN OF THE STEERING GEAR.

two steam capstans and a refrigerating engine working on the J. & E. Hall (Dartford, Kent) carbonic acid system.

The *Kronprinzessin Cecilie* is lighted throughout by electricity, which is generated by three dynamos supplied by the Allgemeine Electricitaetsgesellschaft, of Berlin. The engines driving these generators are of the compound type, furnished by Daevel, of Kiel, and are directly coupled to the dynamos, which work at 102 volts, and a maximum of 250 revolutions per minute, the output of each dynamo being 400 amperes. Two of these engines are placed aft in the main engine room, and the third is above the waterline, in a room forward of the engine hatch, on the upper deck. The total number of lamps is 1,087, while the electricity is used for a great many other purposes, including the outfit of the gymnasium, a wireless telegraphy equipment fitted in a room of the officers' house on the boat deck, telephones, a complete bell system, and ventilating fans, of which latter there are 188.

MODERN MARINE TRANSPORTATION.

BY WILLIAM T. DONNELLY.*

Modern marine transportation may be said to have begun with the first successful application of steam power to the propulsion of ships, and it would seem almost beyond belief that the present year completes but the first century of its application.

Man, since his advent upon the earth's surface, has followed but two callings—that of war and that of trade. The first has been a calling of destruction and annihilation, the second a calling of construction and production—the one tearing down, the other building up. And if there is one single thing which gives us confidence that the present civilization is to remain upon the earth, it is that transportation is binding all nations into one commercial body. It must be apparent to all broad thinkers that the development of the means of transportation upon the great bodies of water that divide the great nations of the earth has been the incentive to the making of international treaties of peace, which are constantly making war and conquest less and less a normal occupation of mankind.

Great as has been the development of transportation upon the sea, even greater development has been made upon land. The application of steam power to land transportation commenced about the same time, and its development has measured the march of civilization. The savage and the wilderness cannot exist where the railroad penetrates. Up to the present time, land and marine transportation have developed independently, and to a large extent in hostility to each other, although both have been using the same great force.

*Consulting Engineer, 132 Nassau St., New York.

The railroads, on the one hand, have persistently contended that wherever a line of rails was possible, marine transportation was useless. The exponents of marine transportation have contended, on the other hand, that the railroads simply served the purpose of bringing the materials for transportation to the harbors of the world for shipment. It now appears that land transportation, as exemplified by the railroads of the country, has reached that point in its development where it is more than ready to forget its hostility, and to call upon marine transportation for assistance in handling the transportation of the continent, and this in spite of the fact that it has taken advantage to the fullest measure of corporate organization and such general confidence of the people as has enabled it to call to its aid almost unlimited capital; while, on the other hand, marine transportation in almost every instance has been developed by individual energy, organization and management.

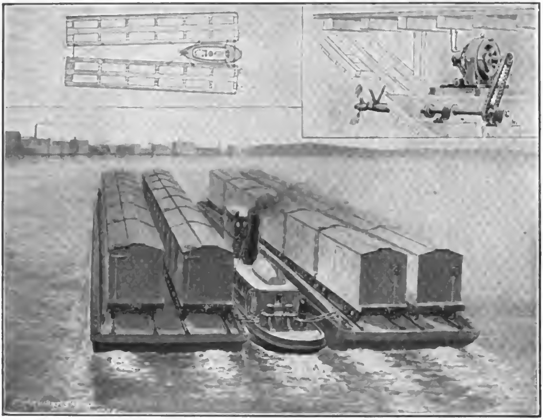


FIG. 1.—MARINE UNIT SYSTEM APPLIED TO CAR FLOAT SERVICE.

THE ELECTRIC UNIT SYSTEM OF MARINE TRANSPORTATION.

This has for its foundation the broad application of the central station idea for the generation of power, its distribution by electricity, and its application to marine transportation. The system is applicable to all classes of marine work.

The marine transportation unit comprises a power vessel containing an electric power generating plant, and a number of cargo carrying consorts, each propelled by electric power furnished from the power vessel. The power plant is of precisely the same construction, operation and control as those used upon land. This power plant has no direct connection, other than electrical, with the propelling power of the vessel in which it is carried, or of any other of the fleet, consequently

the generating engines may be operated at a constant speed and in one direction only, which results in a much simpler form of engine, requiring less attendance, and much less liable to derangement while in operation.

The power vessel (see Fig. 4) contains two boilers of the marine type, each of 700 horsepower, and two directly connected electric generating units of 700 horsepower each. The duplication of the boilers and generating plant make total failure of power highly improbable. Heretofore in all marine work there has been the necessity of a concordant action between the pilot house and engine room, to control the vessel; under this system the engine room and power producing plant are entirely separate and independent of the navigation and control of the vessel, the generation and use of the power being entirely separate functions. The power vessel is propelled by twin screws operated by electric motors; the control of these motors is entirely independent of the power plant, and their starting, stopping and reversing will be under the direct control of the navigating officer in the pilot house, without the intervention of bells or signals of any kind.

The power boat is shown in another view, in connection with two car floats. Each of these is provided with twin screws operated by electric motors, and the control of these motors for stopping, starting and reversing is also located in the pilot house of the power vessel, and under the direct control of the navigating officer. The application of the system involves the principle of so distributing the power that each of the units receives the amount necessary to propel it at the same speed, thus eliminating any necessity of transferring strains between the vessels.

In another case, Fig. 3, the system is shown as applied to canal, river, harbor and lake navigation. The generation of the power is precisely similar, but in this case the electric connection between the vessels comprising the fleet is extended, so that they may proceed in single file, and the control of the propelling power of each vessel is in the hands of the helmsman or officer in charge of that vessel.

In the illustration, the power boat is shown as the last in the line, but it is, of course, apparent that it can occupy any position, and it can be readily seen that in such a fleet each vessel, within reasonable limits, possesses all the qualities of an independent vessel propelled by power, such as the avoidance of obstructions, the ability to turn sharp bends in rivers, and independently to maneuver around wharves and through locks of canals. In addition, the illustration shows the further possibility of using power generated in a central station, upon one of the boats, for refrigerating purposes on others, and it is pointed out that when such a refrigerated cargo reaches its destination, connection can be made to any source of electricity upon the shore, and refrigeration continued while the cargo is being discharged and a new one loaded.

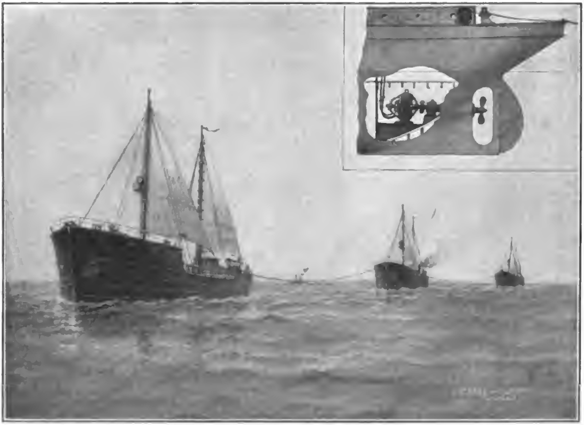


FIG. 2.—MARINE UNIT SYSTEM APPLIED TO OCEAN TRANSPORTATION.

Fig. 2 illustrates the application of this system to ocean navigation. In this illustration three vessels are shown, the central one containing the power plant, distributing power to a vessel ahead and another astern. For this class of work the power vessel would be provided with an automatic winding engine to control the length of the electric cables conveying the power to the other vessels of the fleet.

In the application of the system to the smallest class of shallow river vessels, the power is generated by an internal combustion engine using oil as fuel, and the propulsion is by means of stern wheels. With this system it is possible for

one man to care for the generating plant, and to control the movement of the three vessels comprising the fleet. The system makes possible marine transportation on a less draft than has been heretofore possible. Attention is called to the fact that the three vessels are precisely alike, and that there is no necessary structural connection of the power generating plant to the hull; so that, in case of injury or grounding, it can readily be transferred to any one of the barges.

It should further be considered that this system offers a very great additional advantage, in that it provides for a source of light without a separate installation for that purpose, the lighting circuit being, of course, taken direct from the main power circuit; and as all modern freight movement proceeds without interruption, night and day, this consideration is by no means a small one. It will be readily understood that the readiness with which electricity could be utilized for searchlights for river navigation at night would materially add to the efficiency of the system.

Further general advantages of the system are as follows: all inland water navigation is hampered and limited by the small depth of water, which limits the size of transportation units, and by limiting the amount of water on which the propelling apparatus can act, seriously restricts the application of power in large units. The electric unit system makes possible the development of power in large units, its distribution to a number of small vessels, to each of which it is applied most economically and with the smallest amount of attendance. The placing of the power plant in one vessel and the providing of the cargo space in others makes it possible to adapt each to the particular use for which it is intended, and a much higher economy in construction and operation is possible for each.

It is an established practice to operate tow-boats twenty-four hours per day, while with steam freight carrying vessels it is an established fact that more than half the time is spent in discharging and loading cargo; this is fully brought out in the comparison made in another part of this paper, where the resulting economy of this system is pointed out. The application of this system of navigation to the smaller rivers and waterways of the interior will result in a very great extension of the business and very many economies in operation.

At the present time such navigation is carried on by a steam propelled vessel of sufficient capacity to carry all the freight for the territory which it serves, and it is under the most severe restrictions as to the matter of draft, and consequently displacement, and at the same time must have sufficiently powerful machinery to make headway against strong currents. At every point where freight is received or discharged the vessel, with the entire crew, must remain idle while the freight is being received and discharged.

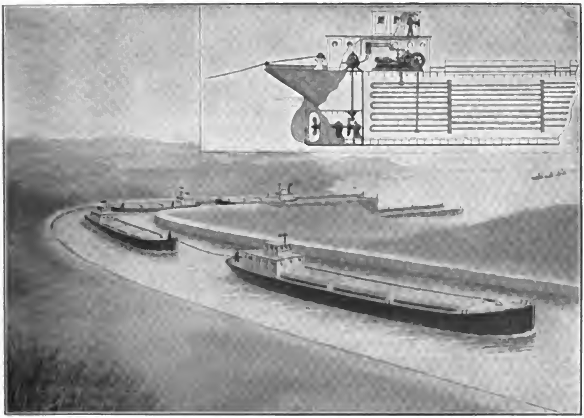


FIG. 8.—MARINE UNIT SYSTEM APPLIED TO RIVER, LAKE AND CANAL TRANSPORTATION.

On the other hand, through the electric unit system, a power boat designed for that purpose only, capable of transmitting propelling power to a number of lightly constructed, shallow-draft barges, each equipped with sufficient electrically operated propelling power to meet the conditions, would operate as follows: Instead of the whole transportation unit remaining idle while freight was being loaded and discharged, a single barge, of a capacity sufficient for the particular freight depot, would be detached upon the up-trip at a town or city, the power boat and remainder of the fleet proceeding without delay. This procedure would be repeated at each town along the river. Upon the return trip, such barges as had been loaded would be taken up. In this way the working plant, comprising the greater part of the investment, and by far the greater part of the working force, would be kept

constantly employed and approximately twice the amount of transportation accomplished for the same investment of capital and labor as by the old method.

The collecting of perishable food products, such as are kept in cold storage, will be greatly facilitated, it being clearly recognized by all engineers that the most important factor of cold storage plants is an ample supply of cooling water, and the added fact that upon the water power can be generated cheaper than under any other conditions. When there is the additional consideration that electric power can now be purchased as readily as any other commodity, in all towns and cities, to operate the cold storage plant when the barge is detached from the power vessel, it is practically certain that this system of gathering and handling perishable food products is destined to have an exceedingly wide application.

In the broad application of this system to inland waterways it will, of course, be immediately apparent that the freight barges with their motor power are not in any way limited for their operation to any particular power vessel, but that in the extension of the system, the power vessel will be treated entirely separate from the cargo vessel, and that the cargo vessels will be moved systematically on schedule time by power vessels in precisely the same way as freight cars are moved by locomotives. But it should be pointed out that marine transportation under this system possesses several distinct advantages over the movement of freight upon railroads. The maintenance of right of way is entirely eliminated. All switching and yard work is eliminated; almost unlimited restrictions as to dimensions and carrying capacity is admissible in freight-carrying units, it being understood that any size of unit may be used with the sole provision that the amount of propelling power introduced shall be sufficient to give all the same speed when in transit.

It should also be pointed out that, when the present form of marine freight vessel or tow-boat is laid up, the whole investment is entirely useless for any other purpose; but with this system, an electric power generating vessel, when laid up for a closed season in northern latitudes, or for lack of business at any time, is still available for the generation of electricity for power or lighting. The fact that the power vessel can be laid up at a point where fuel can be stored would make it possible for such a plant to furnish electric power or lighting at a very reasonable figure.

(To be concluded.)

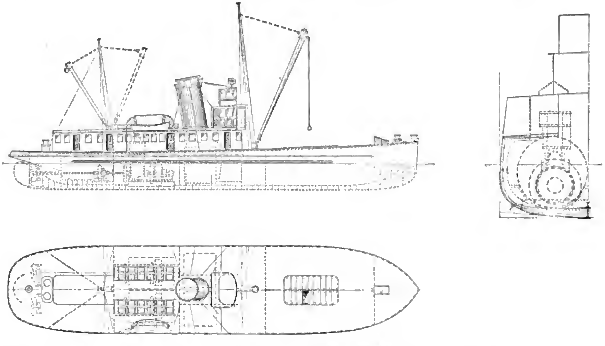


FIG. 1.—MARINE UNIT SYSTEM POWER BOAT.

THE ROYAL NAVAL COLLEGE AT GREENWICH, AND THE TRAINING OF ENGINEER OFFICERS FOR THE ROYAL NAVY.

BY J. W. W. WAGHORN, D. SC.

Few more imposing buildings are to be seen in Great Britain than the noble pile designed and built by Sir Christopher Wren as a home for disabled seamen, and now used as the principal center for imparting technical knowledge to the officers of the various branches of the royal navy. Probably still fewer places are as deeply steeped in historic reminiscences of the Plantagenet, Tudor and Stuart monarchs, or have been more closely associated with the varied fortunes of those houses. The present buildings occupy the site of an earlier building built or enlarged by Duke Humphrey, of Gloucester, the brother of Henry V.

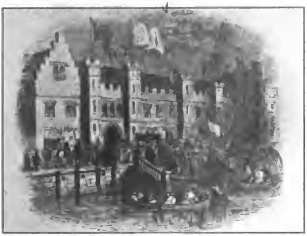
Some idea of these older buildings enlarged by successive monarchs can be obtained from the copies of old prints, which show how they appeared in the times of Elizabeth and of Charles II. The print of 1662 shows also the castle on the rising ground of Greenwich Park close to Blackheath, also built by the "Good Duke," and used as a sort of sanatorium for sufferers from the damper air of the lower ground by the river. The castle was given over for astronomical observations by Charles II, and has been ever since the royal observatory and residence of the astronomer royal from the times of Flamstreet, the first holder of the office. This is also shown in the view of the college grounds and buildings, looking from north to south.

Charles II, some four years after his restoration, commenced to rebuild the palace under the direction of Sir Isaac Denham, who took down the old buildings, of which at the present time no trace remains except the crypt below the block containing the naval museum. After the victory of Cape La Hogue, which shattered the hopes of James II of regaining his

GENERAL VIEW OF THE NAVAL COLLEGE FROM THE RIVER. THE OBSERVATORY IN MIDDLE BACKGROUND.
(Photographs by E. J. Collins, R. N. C.)

lost kingdom, Mary (in William III's absence), in gratitude to her naval heroes, decided that the partially rebuilt palace should be devoted as a home for seamen "disabled by age, wounds or accidents." Wren furnished the designs and lived close by during the completion, and William, after Mary's death, pushed forward the work of rebuilding. Between 2,000 and 3,000 pensioners resided at the hospital at one time, but in later years the number was reduced to about one-half; the men themselves disliked the disciplinary character of the life, and preferred a pension with the freedom of their own homes.

In 1873 the government, in which Goschen was the first

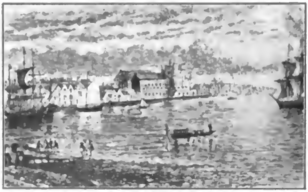


FUNERAL OF QUEEN ELIZABETH AT GREENWICH IN 1603.

Lord of the Admiralty, decided that it would not be inconsistent with the traditions of its past to convert the hospital into a college for the scientific training of all branches of the royal navy. For fourteen years before the establishment of this college an advanced course of instruction in mathematics and technical subjects was held at the Royal School of Naval Architecture and Marine Engineering in some buildings of the South Kensington Museum, attended by a few students of naval architecture and naval engineer students selected annually by examination from those training at the royal dockyards. The course lasted for four years, on what is now known as the "Sandwich" system, about seven months of every year being spent in theoretical study in London, and five months in practical work at the dockyards. The school owed its initiation to the urgent representation of a small committee of the Institution of Naval Architects, of which Scott Russell, the designer of the *Great Eastern*, was an active member, who felt strongly the necessity of an advanced training for engineers and shipbuilders in the interests of the

IN 1662, SHOWING HILL ON WHICH OBSERVATORY IS NOW LOCATED.

country generally, and the Admiralty more particularly. The school was dissolved, and its work transferred to Greenwich on the establishment of the Naval College. That the former school fulfilled the purpose for which it was founded is shown by the fact that nearly all the high technical posts at the Admiralty, and very many at Lloyd's and at the great engineering and shipbuilding firms of the country, are filled by its former pupils.



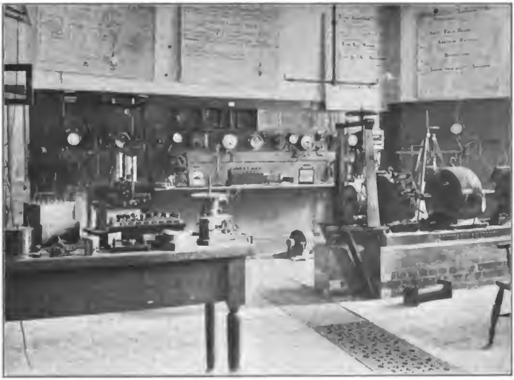
THE BUILDINGS IN 1662.

At the time when the hospital was converted from its earlier

purpose as a home for pensioned seamen it had become gradually recognized that technical scientific education was required, not only for the engineer officers and the future constructors at the dockyards and designers at the Almiralty, but also for all the executive officers of the navy. In the previous days of the old sailing vessels and wooden men-of-war, a knowledge of navigation was the only scientific attainment expected of the naval officers; presence of mind, courage, coolness, readiness of resource and the facility of command sufficed for the rest. When we remember that Columbus, with no appliances beyond the imperfect form of quadrant, known as the astrolabe, and a compass of which even the fact that its setting varied largely at different places was not common knowledge, doubtfully known to himself, with no chronometer, log or chart, was able by dead reckoning, which meant guessing the speed through the water, in each of his voyages from the West Indies, to make his port in Spain with certainty, and to predict at night that a certain land would be sighted in the morning, it is not to be wondered at that a limited mathematical knowledge, with the help of modern appliances, sufficed for the needs of the navy up to comparatively recent times.

During the last half century, however, the modern man-of-war has rapidly become, and with an ever-increasing acceleration, a collection of mechanism of the most complex type; and the executive officer, especially if he undertakes at some time in his career the duties of a gunnery or torpedo lieutenant, must acquire a knowledge (and know a good deal) of the practical side of more than one profession. The naval officer should be proficient in the working parts, and understand the details, of the numerous and complicated items of machinery, hydraulic, pneumatic and electric, required for the working of guns, torpedoes, mines, for transmitting orders automatically to all parts of the ship, and varying from the powerful machinery required for a 12-inch gun to the delicate optical adjustments of a rangefinder. He should know something of the working of his main and auxiliary engines, and have at least an elementary knowledge of naval construction; but included directly in the duties of the executive staff are the motors, dynamos, lamps, searchlights, telephone exchanges and wireless instruments, which make the modern battleship or first class cruiser an electric engineering station of considerable complexity and no mean magnitude.

He should possess the necessary mathematical and technical knowledge required for navigation and pilotage, and understand the troublesome subject of compass errors and their correction, complicated not only by the constant alteration due to a change of geographical position, but also by the varying disturbances due to the close proximity of dynamos, motors and other magnetized masses. Looking at the duties from other points of view, he should be a good linguist, something of a lawyer, acquainted at least with the laws of evidence and practice of courts martial, and be able to cope with the difficult problems of maritime and international law. He should be an expert in naval strategy and tactics, and know something of the duties of the sister service, when in charge of expeditions on shore.



A CORNER OF THE DYNAMO ROOM IN THE ENGINEERING LABORATORY.

When, at the time the Greenwich College was started, the need of a much more extended system of education for the naval officers was felt, arrangements were made by which all executive officers, after they had spent some time at sea and had attained the rank of sub-lieutenant, should compulsorily be appointed to the college for a course of study lasting about six months, and terminated by a qualifying examination. Officers of higher rank, lieutenants, commanders and captains, were encouraged, at periods when not appointed to a commissioned ship, to attend classes in various subjects, such as mathematics, physics, steam, chemistry, languages, fortification, naval strategy, etc. Lieutenants qualifying for gunnery or torpedo duties spent the session of nine months at Greenwich before proceeding to the special training ships for the practical part of their instruction. A war course for senior officers (captains and commanders) was held for several years,

and even a short course for admirals, lasting for six weeks at a time and always well attended, showed that the modern naval officer recognized that at no period of his service was he too old to learn. During the last few years, however, much of the instruction previously given at Greenwich has been transferred to the naval ports. The war courses are held at Devonport, Portsmouth and Chatham, the qualifying courses for the special technical officers (gunnery and torpedo) are held at Portsmouth, and only those who show special ability (about one-third of the number qualifying) proceed afterwards to Greenwich for a more advanced course of nine months' duration.

On the same principle, only those sub-lieutenants (about one-half the total number) who attain a sufficient standard in an examination held at sea, proceed to Greenwich for a further course of six months' instruction. Also, whereas formerly all the engineer officers, after their training at Keyham, came to the naval college for one session, under the present regulation only those most likely to profit by the instruction are appointed. The result of these two conclusions, that where possible naval subjects should be taught in the ports where the fleets assemble, and that only those who have shown particular aptitude should proceed to more advanced education, has resulted in a considerable diminution of the students in residence, who number normally under the present regulations about 100, as compared with almost double this number a few years ago.

In addition to executive officers, engineering officers and students of naval architecture, all marine officers, both of the Royal Artillery and of the Light Infantry, are attached to the college for a period of one or two years. Gentlemen, graduates of the universities, qualifying for the rank of naval instructor, attend the courses, and many individual officers are appointed for work in some particular department before taking up some technical appointment or undertaking some special work.

Candidates who have obtained nominations for the engineering cadetships, of limits of age between 14½ and 16½, are examined annually, and those selected proceed to Keyham for a course of training. It must be remembered, however, that the terms used refer to the past, and that the system that has produced the present officers of the engineering branch is now superseded by the new scheme of a common entry and joint training up to a certain point in their career, for the executive, marine and engineering officers. The education and details of courses referred to in this article apply obviously to the older system, which will soon be obsolete.

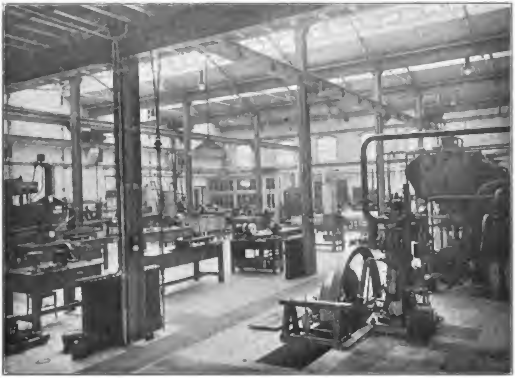
The successful probationary cadets pay £75 ($365) a year towards the expenses of their residences and training at the Engineering College at Keyham, but scholarships are awarded to a considerable number at the head of the list, which reduces the fees to £40 ($195) a year. Such students, engineering cadets, must enter the government service if they are offered commissions at the end of their course of four years. The remainder, probationary cadets, will be allowed to take the commissions, if they are successful in the final examinations, but are not obliged to do so. About one-half of the total entry receive commissions at the end of the course. The training is partly mathematical and scientific, under a staff of which Prof. Worthington, F. R. S., is the head; partly practical and technical, under a staff of engineer lieutenants, one in charge of each term, and an engineer commander, all the organization and general supervision being carried out by an engineer captain; an executive officer of the rank of captain being at the head of the whole establishment.

THE COLLEGE GROUNDS, PAINTED HALL AND CHAPEL.

Two mornings and three evenings in a week are devoted to the mathematical and scientific studies. The rest of the time is spent in the various workshops, iron and brass foundries and in repairs on board ship. A separate fitting shop and a drawing office are allotted to the students. Their work is carried on under the supervision of the engineer lieutenants, assisted by workmen instructors. Whenever it is possible, the whole of the repairs of a certain ship are carried out by the cadets, under the same conditions as by the factory workmen, and the trials run under the usual tests.

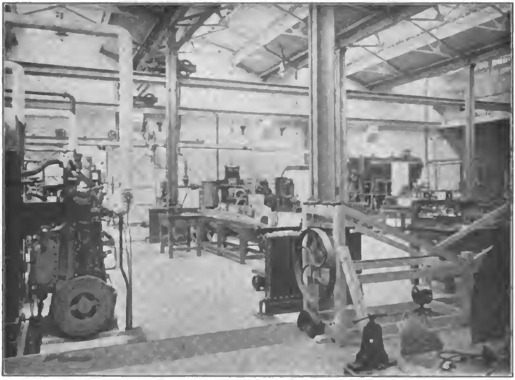
A certain number, generally about one-half of those who obtain commissions, proceed to Greenwich for a course of nine months' further study. At the end of their second year at Keyham, appointments are offered to the first two or three on the examination list to enter the royal corps of naval constructors. The training in their case naturally differs somewhat on the technical side from that of the engineering cadets; they also proceed to Greenwich, and stay there for the full advanced course of three years.

The instruction at Keyham includes algebra, trigonometry, differential and integral calculus, the application of graphical methods to the solution of problems, statics, dynamics and



A VIEW IN THE MECHANICAL LABORATORY.

hydrostatics; mechanical drawing, mechanism and applied mechanics, and strength of materials, with laboratory work in these subjects; lectures and laboratory work in chemistry, including analysis of funnel gases, hardness of water, boiler incrustation, etc.; lectures and laboratory in physics, including optics, heat and the elements of thermodynamics, electricity and magnetism, the applications of electricity in dynamos, motors, wireless telegraphy, etc. The engineering lectures include the description of the parts of various types of steam engines and boilers, properties of steam, indicator diagrams,

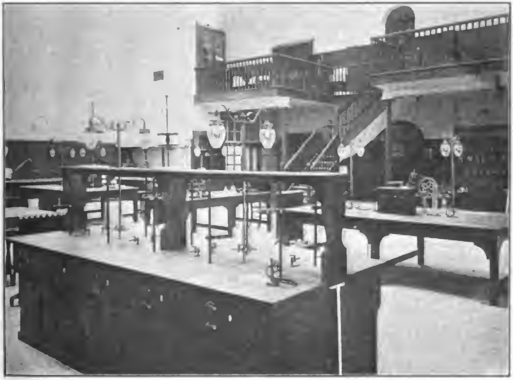


A SECTION OF THE MECHANICAL LABORATORY.

THE APPARATUS IN THE PHYSICAL LABORATORY.

combustion, oil and gas engines, engine room duties, propulsion of ships, hydraulic machinery and the metallurgy of iron and steel and alloys used in naval practice.

A certain number of appointments to the rank of engineer sub-lieutenant have, under the regulations in force up to the present time, been offered to candidates, not trained at Keyham, between the ages of 20 and 23, who have had at least one year's training at a recognized technical institution, not less than three years at some approved engineering firm, and who obtain the requisite qualifying marks in the papers at the final examination to the Keyham cadets. If their examination record is sufficiently good, they can proceed to the advanced



THE NEW CHEMICAL LABORATORY.

course at Greenwich. At the termination of the session's work, a few of the engineer sub-lieutenants, generally about four in number, are selected to stay for a further course of two more sessions (of nine months each) with the view of qualifying for the more important posts at the Admiralty and royal dockyards; all the students of naval construction also stay for the full course of three sessions.

Private students of either marine engineering or naval construction may be admitted to the full advanced courses on passing a qualifying examination and payment of an annual fee of £30 ($146). These students do not,however, reside at the college. Scholarships and free studentships are offered to those private students who attain a certain standard at the entrance examination, and such students may be taken into the Admiralty service at the completion of their studies, competing on equal terms with the students trained in the government establishments. Testimony to the high value of the Greenwich instruction is given by the fact that many foreign governments have, since the first institution of the college, been glad to send the ablest students of their engineering and construction corps, and executive and engineer officers of their respective navies, to join these classes. As long as it was permitted by our Admiralty, the American, Italian, Danish, Swedish, Chinese and Japanese and other governments sent some of their ablest men, and the high offices of the naval construction and engineering departments of the nations were filled mainly with former students of Greenwich. Of recent years, the Admiralty has been less ready to supply the technical training for other countries, but the Japanese have already been allowed to send two or more representative officers, and these men, as we might expect from the known ability and devotion to study of their race, always take good positions in the final examinations, and hold their own, in spite of the difficulties due to their imperfect knowledge of the language, with the best of our own men. At the present time, one Portuguese naval officer, two Japanese students (of naval construction and of marine engineering, respectively) and a Japanese commander who took an active part in the last war, are at the college, and in the ensuing session several Chinese students will be admitted.

The mathematical work of the first year repeats and treats more fully the subjects already taken up at Keyham, algebra, trigonometry, co-ordinate geometry, differential and integral calculus and the mechanics of solids and fluids. In the second and third years the course in pure mathematics includes analytical solid geometry, elementary differential equations, mainly in applications to mechanical and physical problems, curve plotting, etc. In applied mathematics, the mechanics of solids and fluids is treated in much greater detail and by more general methods than in the first year course. Besides the usual problems of statics and dynamics of a particle, are considered the equilibrium of chains and elastic beams, and the general dynamics and kinematics of rigid bodies, special attention being paid to questions involving rotation, gyrostatic control, etc. The naval constructors have also a course in dynamics.

In applied mechanics the first year syllabus for the students is on the same lines and general scope as the final B. Sc. or B. E. at any of the universities. In the second and third years, the work may be compared with a post-graduate course in the higher branches of applied mechanics in relation to design, such as secondary balancing of engines, vibration of structures, whirling of shafts, etc. Thermodynamics of the steam engine and steam turbine, of internal combustion engines, of refrigeration and air compressors, design of centrifugal pumps, of turbines and other hydraulic plant, are taken up; with lectures on stream lines and wave motion and resistance and propulsion of ships.

An important feature of the instruction of this department is the course of practical work in the newly equipped laboratory, of which two views are given. Experiments are carried out in the first year illustrating the efficiency of lifting tackle, the laws of linear, angular and harmonic motion, illustrated by the usual apparatus, such as the ballistic pendulum, the gyroscope, etc.; the laws of friction, the measurement of elastic constants of materials, the discharge through orifices, etc.

In the last two years the extended course includes the testing and microscopic examination of metals and efficiency tests of various types of boilers and engines (steam, hydraulic and internal combustion). In the third year research work in various subjects is undertaken, in which the students are expected to use their own powers of resource and originality. During the last term investigations have been carried out on the efficiency of injectors, of petrol engines, on lubricants, on the application of Hele Shaw's stream line apparatus for the estimation of mechanical stresses in structures, on the hardness and ultimate strength of iron-carbon alloys, on the mechanical properties of materials, coupled with microscopical examination and chemical analysis.

The plant includes, among other items, a marine engine of 50 horsepower by Belliss & Morcom, coupled to a Siemens shunt dynamo; a 33-kilowatt Parsons turbine and direct-current generator, and a 20-kilowatt De Laval turbine and generator. The internal combustion engines include a 15-horsepower Diesel, 12-horsepower Thornycroft petrol, 12-horsepower Crossley gas and 2½-horsepower Hornsby-Ackroyd hydraulic. A 100-ton hydraulic testing machine by Rushton; an air refrigerating machine and air compressors; an equipment by Zeiss for the microscopic examination of metals, and a dark room for photographic work are also provided. The building is lighted and supplied with alternating current from the mains of the South Metropolitan Company, and a battery of 55 storage cells enables direct current to be obtained, when required. A well-equipped work shop, with lathes, shaping and milling machines, serves for the construction of new appliances and the repairs necessary for those existing.

A very considerable proportion of the working hours of the engineer sub-lieutenants is devoted to the design and drawing of engines and their component parts. Lectures and notes on the parts designed are given by an engineer officer on the Admiralty staff, assisted by an engineer officer attached to the college. About six hours a week are given in the first year to this subject, which enables the student to complete about ten finished drawings, with calculated dimensions of parts, such as the crankshaft, piston, piston rod and crosshead, etc., suitable for the engines of a given ship.

In the second and third years about ten hours a week are devoted to this subject, during which time a complete design in full detail of a set of main engines for a given ship is worked out. Two students work together, and complete about twenty drawings, including the general plan and elevation of main and auxiliary engines, details of parts, and arrangement of pipes in boiler and engine room. Lectures on naval architecture are given by a member of the corps of naval constructors, and lectures on points of present interest in naval practice, such as oil fuel, turbines and internal combustion engines, by an engineer commander attached to the college and in charge of the instruction to executive officers in steam, mechanism and machine drawing.

The first year students attend lectures on the application of electricity, in continuation of their previous courses at Keyham, including the principles and service details of arc lamps, searchlights and glow lamps, of continuous-current dynamos and motors, of alternating-current circuits and their properties, of the various types of alternating-current dynamos and motors and their characteristic properties, transformers, rectifiers, etc., on the transmission of power, and the principles and

apparatus involved in wireless telegraphy. These lectures are supplemented by practical work in the physical laboratory, including efficiency tests of the various types of dynamos and motors, transformers, lamps, rectifiers, etc., the determination of the magnetic constants of materials, of capacities and inductances, etc.

The plant includes a 12-kilowatt motor-generator set by Siemens, shown in the view of one corner of one of the dynamo rooms, consisting of a shunt-wound motor coupled on either side to a direct-current compound dynamo. These dynamos can be uncoupled from the motor and driven as shunt, series, cumulative or differential motors from the direct-current mains. The machines are fitted with slip rings connected to the armature, and will consequently generate three-phase current, either as dynamos or motors. They can be driven as rotary converters, either from the direct or alternating side, and can be used as synchronous motors. The plant is also conveniently arranged for efficiency tests on the usual Hopkinson method. Another motor-generator set by Crompton consists of a two-phase induction motor driving on one side a continuous current dynamo and on the other a two-phase generator, which can also be run as a single-phase or two-phase synchronous motor. A motor generator set by Schuckert provides continuous current from the alternating mains of the South Metropolitan Company. Among other items are a four-pole and a two-pole compound dynamo by Siemens; a small alternating generator and separate exciter by Johnson & Phillips, and two and three-phase induction motors from 12 to 2 horsepower by the same firm. Rooms are fitted up for the testing of arc and glow lamps; for the measurement of inductances; for calibration of instruments by Crompton's potentiometer, for the use of wave meters in wireless experiments; for observations in terrestrial magnetism; for compass correction; for work in heat and light, and for a course of elementary mechanics and hydrostatics. Another view shows a portion of the large room used for ordinary electrical measurements, with Wheatstone bridges, etc. A dark room and thoroughly equipped photographic studio is also attached to the department.

The lectures in chemistry deal, besides the general principles, with such practical applications as fuels, boiler incrustations, etc. A course of lectures on metallurgy is also given in this department. In the first year, the practical work is mainly qualitative analysis; in the second year, on the testing of coal, liquid and gaseous fuels and their analysis, physical and chemical examination of lubricating oils, examination of water for use in boilers, etc. A view of a portion of a large room recently added to the chemical laboratory is shown.

Instruction in languages, French and German, is given to those taking the long course. All officers are requested to spend a certain time every week in the exercises of the Swedish physical drill. The recreations in the college life have not been neglected; there are two racquet courts, many lawn tennis courts, a fine bowling alley and a billiard room. The lease of a football and cricket ground a little distance from the college ground will, unfortunately, terminate this year, and pass into the hands of the speculative builder.

The courses of study, and all the educational arrangements, are under the control of the director of naval education, Professor I. A. Ewing, F. R. S., who is also responsible for all the other educational establishments connected with the Admiralty, and for all matters pertaining to the training of the personnel of the navy. An "admiral president" is at the head of the college, and is assisted in all matters of discipline by a naval captain. It must, of course, be borne in mind that the education and training of the engineer officer as shown in this sketch refers to the present and the past, but that in a very short time a new system will take its place, of which the general scheme, but not the details, are yet public.

Italian Armored Cruiser Pisa.

On Sept. 15 there was successfully launched from the shipyard of Orlando Brothers & Company, Livorno, Italy, the first of four first-class armored cruisers building for the Italian navy. The ship has the following dimensions:

	Meters.	Feet.
Length over all	140.5	461
Length between perpendiculars	130.	427
Extreme beam	21.06	69
Depth	12.15	39.9
Mean draft	7.18	23.6
Maximum draft	7.43	24.4
Metacentric height	1.2	3.94

Normal displacement in tons, 10,118.

LAUNCHING OF THE ITALIAN ARMORED CRUISER PISA.

This ship is propelled by twin screws actuated by triple expansion engines, with a designed horsepower of 19,000 under forced draft, and at 132 revolutions per minute. This is expected to give a speed of 22.5 knots, with a corresponding speed of 20 knots at 15,200 horsepower and natural draft. Steam is supplied by twenty-two watertube boilers of the Belleville type, fitted with economizers.

There is a complete armor belt running from stem to stern, with a width of 7 feet 3 inches, of which 4 feet 11 inches is below the waterline. The maximum thickness is 7.87 inches, decreased to 3.16 inches at stem and stern. The protective deck has a thickness of 1 inch.

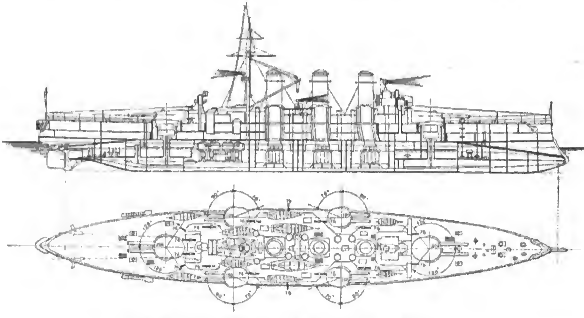
The battery is an extremely powerful one, including four 10-inch guns, 45 calibers long, mounted in pairs in turrets forward and aft, with an arc of fire of 260 degrees, half each side of the center line. The height of these muzzles above the water plane is 24 feet 3 inches. There are eight 7.5-inch guns, 45 calibers long, in pairs in four turrets at the corners of the superstructure. These have an altitude above the water of 22 feet 2 inches. They have a range of fire of 160 degrees, of which 90 degrees comprehends the arc between the fore-and-aft line and the beam for the various guns. The secondary battery includes sixteen 3-inch guns, eight 3-pounders and four Maxims. There are three 18-inch torpedo tubes, all submerged, two being located just aft of the ram, while the other one is just above the rudder. All of the artillery is of the latest Vickers type, and was made in Barrow-in-Furness.

These ships are such an advance over anything else of the

	Pisa.	*Charleston.*	*Cornwall.*	*Tokiwa.*	*Marseillaise.*
Displacement in tons	10,118	9,700	9,800	9,750	9,856
Horsepower	19,000	27,200	22,700	20,550	21,800
Speed in knots	22.5	22.03	23.69	23.09	21.64
Admiralty constant	281	179	268	274	214
Main battery	Four 10" Eight 7.5"	Fourteen 6"	Fourteen 6"	Four 8" Fourteen 6"	Two 7.6" Eight 6.4" Six 3.9"
Broadside in pounds	2,8cc	800	900	1,700	822

same size and type yet laid down that a comparison with some of the efforts of other powers will doubtless be interesting. With this idea in view we will compare them with the *Charleston* class of the United States navy, the *Cornwall* class of the British navy, the *Tokiwa* class of the Japanese navy, and the *Marseillaise* class of the French navy. These ships are all near enough of a size to make a comparison worth while.

The splendid propulsive results achieved with the *Cornwall* and *Tokiwa* will in all probability be equaled or surpassed by the *Pisa*, such is the extremely high character of Italian design from this point of view. In comparison, the *Charleston's* performance is truly pitiable, and her broadside is the weakest of the five, being less than 30 percent as powerful as that of the *Pisa*, and at long ranges much less even than that small percentage.



INBOARD PROFILE AND BATTERY PLAN OF THE NEW ITALIAN ARMORED CRUISER PISA.

The aggregate tonnage of vessels going alongside the wharves in Hamburg harbor, Germany, during 1906 amounted to some 6,000,000 tons net. Of these vessels 2,551, an aggregate of 3,900,000 tons, carried the German flag, showing a notable increase as compared with the previous year. As for England, there was a slight decline in tonnage, compared with 1905, the figures being respectively 1,520,000 tons and 1,580,000 tons, while the number of vessels was about the same—2,056 and 2,054. Norway accounts for 296 vessels with 159,000 tons, Holland has 281 vessels with 158,000 tons, which means an increase of some 50 percent. Denmark comes next with 321 vessels and 93,000 tons; and then France with 84 vessels and 75,000 tons—about the same as the previous year. Sweden shows a slight decline, with 124 vessels and 60,000 tons. Of other countries, Spain accounts for 20,000 tons; then come Italy with 12,000 tons, Russia with 6,000 tons, and Austria-Hungary, with one solitary vessel of 3,000 tons. The United States of America was not represented at all.

A New 150-Ton Hydraulic Crane.

The crane has been erected for the Elswick Ordnance Works of Sir W. G. Armstrong, Whitworth & Company, Limited, and is of the fixed luffing type. All the motions, rotating, hoisting, and raising the jib, are performed by hydraulic power. The crane is intended for handling guns and their mountings, and for general use in completing large warships. Owing to the increasing size and breadth of modern vessels, the shear legs hitherto used for this purpose have not sufficient reach over the water.

The crane is capable, when working with an effective pressure of 750 pounds per square inch, of lifting a load of 150 tons from 15 feet below to 85 feet above quay level, or through a total height of 100 feet. The maximum rake or radius with this load is 99 feet, and the minimum rake 44 feet, the maximum outreach beyond the face of the quay being 74 feet. Auxiliary lifting machinery is fitted for dealing with lifts up to 25 tons, the maximum rake for this lift being 117 feet and the minimum rake 50 feet. The range in turning is unlimited.

The pedestal is constructed of steel plates and angles, and has an archway through it of such size as to allow of two lines of rails being laid through it. It measures 38 by 45 feet across the corners. The pedestal is bolted to the foundations by 24 wrought iron holding down bolts, six at each corner. The revolving portion of the crane is carried on the top of the pedestal, and turns on a ring of steel "live" rollers

working between roller paths of cast steel, a steel central pivot being also fitted. The external diameter of the roller path is about 38 feet. The pillar, framing and jib are of steel plates and angles strongly braced together.

The main lifting machinery is in two sets, each set being capable of lifting 75 tons, stop valves being provided so that each set can be worked independently, or in conjunction with the other set. Both are contained in the pillar, and each consists of two hydraulic cylinders with rams acting on a common crosshead fitted with multiplying gear (8 to 1), guides and steel wire lifting rope 7 inches in circumference with a breaking strength of about 160 tons. Each rope is and fitted with a swivel hook and an overhauling weight.

The luffing machinery is placed on an inclined frame at the back of the pillar, and is of the direct-acting type, there being two hydraulic cylinders, the plungers of which working downwards act together on a forged steel crosshead, to the ends of which are attached the back ends of the steel luffing stays, the outer ends being attached to the jib head, so that the motion downwards or upwards of the crosshead luffs the jib in and out, respectively. The crosshead works on forged steel guide plates bolted to the inclined luffing frame, the guide pieces on the crosshead being fitted with gunmetal faces. An overhauling cylinder for assisting in luffing out

GENERAL VIEW OF THE NEW ELSWICK CRANE HANDLING A 12-INCH TURRET.

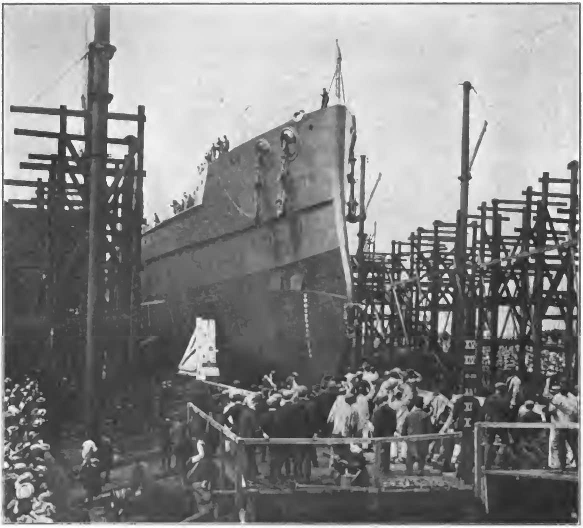
doubled over an equalizing sheave near the jib head, and led over the sheaves in the purchase blocks; thence by conveyance and the multiplying sheaves to fast ends on the cylinders, the arrangement being such that the 75-ton load on each of the two purchase blocks is taken on four parts of the rope. The purchase blocks are counterweighted so as to act as overhauling weights, and the shackles are fitted with swiveling arrangement.

The auxiliary lifting machinery is contained in a steel framing secured to the front of the main pillar, and consists of a hydraulic cylinder and ram fitted with multiplying gear (4 to 1), guides, conveyance sheaves and steel wire rope 7 inches in circumference, with a breaking strength of about 160 tons, the rope being led over a sheave on the jib head, the jib when unloaded is placed between the luffing cylinders, being fitted with ram, guides, multiplying gear (2 to 1) and two 1 5/16-inch overhauling chains acting on the luffing crossheads. This cylinder is always open to the hydraulic pressure when the crane is at work.

The crane is turned by a hydraulic motor of the oscillating-cylinder pattern, having three cylinders and rams, and actuating, through spur and bevel gear, two forged steel pinions engaging with the turning rack, which is bolted to the top of the pedestal. The turning machinery has two changes of gear, so that the power and speed in turning can be varied to suit the load being dealt with, clutches being provided for putting either set of gear in or out of action. A brake is fitted on the turning gear. The valves for controlling the

lifting, luffing and turning motions are fixed on the floor of the revolving platform in a house which also contains the turning motor and gearing. The levers for actuating the valves are operated from a working cabin placed above this house near the foot of the jib.

Sufficient cast iron ballast is provided to give a reserve of stability of 50 percent when the full working load of 150 tons is suspended at the maximum rake. Ladders and platforms are provided for giving access to the various parts of the machinery. The crane is placed on a heavily piled foundation, there being four groups of piles, one under each leg of the pedestal.



THE BOW OF THE BELLEROPHON, AFTER THE SHIP HAD STARTED DOWN THE WAYS.
(Photograph, Cribb, Southsea.)

The crane was designed for lifting the full load at a speed of 30 feet per minute, and to make a complete revolution in turning in 1¼ minutes. These speeds, however, could be considerably exceeded if sufficient accumulator power is available. In tests, a load of 200 tons was easily raised.

THE BATTLESHIP BELLEROPHON.

Following the successful trials of the *Dreadnought*, three new vessels of the same type were laid down, and have now been launched. The *Bellerophon* was put into the water July 27 last from the Portsmouth dockyard; the *Temeraire* on Aug. 23 from the dockyard at Devonport, and the *Superb* on Nov. 7 at the Elswick yards, Newcastle-on-Tyne. These ships are somewhat larger than the *Dreadnought* in displacement, although of the same overall dimensions. They represent certain improvements over the earlier ship, prominent among which are an increase in the length of the 12-inch guns from 45 to 50 calibers, and the raising of the central turret so that its guns may be fired over the after turret, and thus increase the astern fire of the ship.

The displacement is 18,600 tons, as compared with 17,900 in the *Dreadnought*, the difference being due to an increased fullness in the form of the hull, and also to a slight increase in the draft. The weight of the hull and armor is stated to be 11,800 tons as compared with 11,100 in the case of the prototype. The launching weight of the *Bellerophon* was above 7,000 tons, and of the *Temeraire* 7,475 tons. The length is given as 490 feet between perpendiculars, with a beam of 82 feet and a draft of 26 feet 3 inches.

Propulsion is by means of four screws actuated by Parsons turbines, with a designed shaft horsepower of 23,000 and a designed speed of ship of 21 knots. With 900 tons of coal at normal draft, it is estimated that the radius of action at 12 knots would be 5,800 nautical miles. It is possible, however, to carry a total of 2,500 tons of coal and oil.

The main defensive armor consists of a belt with a maximum thickness amidships of 11 inches, decreased to 4 inches at the

ends. The heavy guns are in turrets protected by 11-inch armor, while the two conning towers are armored with 11 inches (forward) and 8 inches (aft) of steel. The protective deck has a thickness on the slopes of 2¾ inches, decreased to 1¼" on the flat. Some protection has been given the ships in a cellular construction of the hull to avoid the disastrous effects which might be expected from a torpedo, thrown by either a torpedo boat or a submarine vessel.

The main battery consists of ten 12-inch guns, 50 calibers long, and located in pairs in five turrets. Three of these turrets are on the center line, one being on the forecastle, one on the after deck, and one aft of amidships, and at such an elevation as to be able to fire over the turret on the after deck. The two remaining turrets are placed, one on either beam, somewhat forward of amidships, and it is said that they can direct their own fire throughout a semi-circumference, from straight ahead to straight astern. This gives a broadside of eight of these powerful weapons, a theoretical bow fire of six, and a theoretical astern fire of eight. The probable maximum bow and stern fire at sea, however, would be four and six guns, respectively. The secondary battery, which is intended for defense against the attack of torpedo vessels, consists of 4-inch guns in place of the 3-inch weapons on the *Dreadnought*. In addition, there are five submerged torpedo tubes for 18-inch torpedoes, one tube being right astern, while the others are on the broadside and bows.

The ship will be steered by two rudders, as in the case of the *Dreadnought*, and of the new battle cruisers of the *Inflexible* type, and it is said that steering gear of a new type is to be fitted. One of the many minor departures from the *Dreadnought* design is the placing of the tripod mast astern of the two funnels, instead of between the two as in the type ship.

STERN OF THE BELLEROPHON BEFORE LAUNCHING, SHOWING STERN TORPEDO TUBE AND TWO OF THE PROPELLER STRUTS.

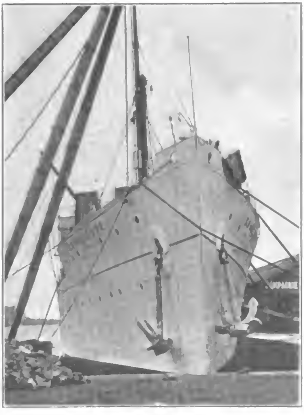
The French Liner Guadeloupe.

BY JULES PELTIER.

This vessel was given some description in our issue for September last, she having been launched from the yards of the Chantiers de l'Atlantique at St. Nazaire during the early spring. She entered into service by starting Sept. 27 last from Bordeaux for the West Indies. She is the largest and most modern vessel running between France and her American colonies, and is shortly to be followed by her sister ship, *Perou*. The ship has the following dimensions:

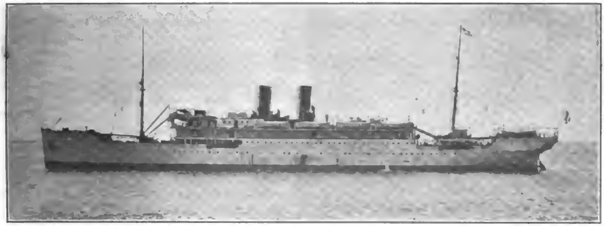
"SETTING UP" THE BELLEROPHON, JUST PREVIOUS TO HER LAUNCHING.
(Photograph, Cribb, Southsea.)

	Meters.	Feet.
Length over all	136	447
Length between perpendiculars	131.84	432
Extreme beam	15.92	52.2



A BOW VIEW OF THE GUADELOUPE.

VIEW LOOKING AFT FROM FORECASTLE.



THE FRENCH WEST INDIA LINER GUADELOUPE, BUILT BY THE SOCIETE DES CHANTIERS DE ST. NAZAIRE.

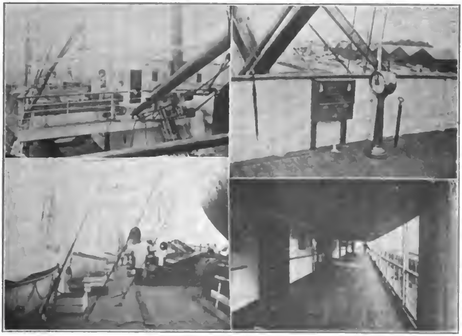
Depth	9.57	31.4
Mean draft	7	23
Gross register tonnage	6,585	
Net tonnage	2,968	

There are two propellers actuated by triple expansion engines, each in a separate watertight compartment. The cylinders have diameters of 27, 43 and 72 inches, with a stroke of 48 inches, and are operated at 90 revolutions per minute. Steam is supplied by six single-ended Scotch boilers with a length of 10 feet 11 inches and a diameter of 14 feet 1 inch. Each is fitted with three furnaces, the total grate and heating surfaces being, respectively, 345 and 13,451 square feet. The ratio is 39 to 1. The boilers of the *Perou* are fitted with Pielock superheaters, while the engines have Lentz slide valves. The boilers and engines of the *Guadeloupe* are fitted with the usual arrangement, which fact will permit the owners to obtain splendid comparative results to guide them in future construction.

On trial trip the *Guadeloupe*, with a displacement of 9,600 tons, obtained 17 knots with 6,580 horsepower, the boilers working under Howden's forced draft system.

The outfit includes a set of dynamos supplying electricity for lighting, ventilating, operating capstans and boat winches, and various signaling and telltale devices. The refrigerating plant will permit the ship to carry fruits and other perishable goods. The twelve steel lifeboats are fitted with Welin quadrant davits.

The question of subsidy entered very largely into the construction of these vessels. It is estimated that the shipbuilding subsidy for the hull of each amounted to 925,192 francs, while for the machinery the total is given as 401,250 francs. This makes an aggregate of 1,326,442 francs (£52,550, or $255,800). As the vessels also come under the merchant cruiser act, they will receive daily for each ton up to 3,000 gross register 4 centimes; 3 centimes for each ton between 3,000 and 6,000, and 2 for each subsequent ton. This would make for each a total of 221.70 francs per day, subject to an increase of 30 percent because of the speed, making a total of 288.20 francs per day. This aggregates 103,755 francs per year (£4,112, or $20,020). The combined shipbuilding and ship operating subsidies thus obtained for these vessels ought to make them a very profitable proposition for their owners.



VARIOUS DECK SCENES ON THE STEAMSHIP GUADELOUPE.

INTERNATIONAL MARINE ENGINEERING

Published Monthly at

Christopher St., Finsbury Square, London, E. C.

E. J. P. BENN, Director and Publisher

and at

17 Battery Place New York

By MARINE ENGINEERING, INCORPORATED

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President

E. L. SUMNER, Secretary

SIDNEY GRAVES KOON, Editor

Branch Offices { Philadelphia, Machinery Dept., The Bourse, S. W. Anness.
Boston, 170 Summer St., S. I. Carpenter.
Chicago, 625 Monadnock Block, Howard S. Moss.

Entered at New York Post Office as second-class matter.

The edition of this issue comprises 15,000 *copies.*

Battleship Construction in Britain.

Up to the present time the British Navy is the only one which has afloat any vessels of the distinctively *Dreadnought* type: That is to say, vessels whose primary armament includes eight or more guns of the highest power, and whose secondary armament is of small weapons, intended solely for use against torpedo craft. The original *Dreadnought* has been in service for more than a year, and the three sister ships, of slightly increased displacement, *Bellerophon, Temeraire* and *Superb,* are all in the water. Three new ships are about to be laid down, two of them being, respectively, the *St. Vincent* and the *Collingwood.* These are reported to embody a somewhat further increase in displacement and effectiveness upon their predecessors of the *Bellerophon* type. In addition to this splendid array, we must note the three so-called armored cruisers, which are in reality, by virtue of their offensive and defensive powers, battleships of great strength and tremendous speed, and which go by the names of *Indomitable, Inflexible* and *Invincible.* This makes a total of ten ships, of which seven are already afloat. As compared with this, Germany has four ships of 19,000 tons on the stocks; the United States has two of 16,000 tons and two of 20,000 tons building; and Brazil has three large ships building in England. This exhausts the list of *Dreadnoughts* proper. Ships of somewhat similar characteristics, however, are not wanting on the stocks of other nations, for France is building six vessels of the *Danton* type, of 18,350 tons; Japan has already launched two vessels of the *Satsuma* type, of 19,500 tons, and is reported to have others in hand; and Russia has a program calling for the construction of several such vessels.

The great feature of all of the ships of the *Dreadnought* type is the possibility of great concentration in the fire of heavy guns, and of an exceedingly effective attack at long battle ranges. Our readers need not be reminded that of two shells with the same initial velocity, that one which is heaviest will best maintain its velocity, and hence its energy of impact, and the greater the excess weight the better will this velocity be maintained. A 12-inch shell would be exceedingly dangerous at a point where a 6-inch projectile would have lost almost all of its kinetic energy. It is for this reason that the ships in question have been fitted with these heavy guns in such a way as to give a tremendous fire at great distances. Each of the ten British ships above mentioned can concentrate on either broadside eight 12-inch guns, with a bow and stern fire of from four to six. The American *Michigan* class can place eight guns upon the broadside and four at bow and astern. The *Delaware* class can concentrate ten of these guns upon the broadside and four at either end. The German ships are fitted with 11-inch guns, and, while details are not thoroughly well known, it is believed that ten can be brought to bear upon the broadside, and six forward or aft. The Brazilian ships are reported to be something of a compromise between the *Dreadnought* and the *Indomitable,* so far as distribution of guns is concerned, and to have a broadside battery of no less than ten of the 12-inch size.

The Naval Architects' Convention.

In this number will be found reports in brief covering the various papers and discussions at the recent convention of the Society of Naval Architects and Marine Engineers, in New York. It is our purpose to publish ultimately about half of the fourteen papers presented, but demands upon our space make it possible for us to publish in this issue only two of the seven or eight which will ultimately appear. As has been our custom for some years past, we are reporting the salient points of the discussions, as well as giving abstracts of all the papers, feeling, as we do, that in many cases there is as much value in the discussions as in the original papers, because they bring to bear on any given subject the united efforts of many minds,

approaching the problems from almost as many different points of view. We have not considered it necessary to go so extensively into the discussions as has been done on certain occasions in the past, but have carefully excised all remarks which did not bear directly upon the subject in hand, or upon one very closely related to it.

Both papers which we are publishing in this number are of particular note, and for different reasons. Mr. Taylor's paper, describing the effects of experiments to determine the location of stream lines upon the hulls of ships, may almost be said to be epoch-making in its originality and in the unique results obtained. It has resulted in upsetting, to a very large degree, all preconceived ideas with regard to the flow of water around the hull of a ship during the progress of the ship through the water. As a matter of fact, these experiments seem to indicate that a ship virtually climbs upon the water in the forward portion and then slides down from this pinnacle in the rear. This fact will, perhaps, explain some things which have heretofore been rather obscure and imperfectly understood. For instance, we have all noticed the peculiar position taken by a very fast torpedo boat or motor boat when running at full speed. The bow tends to rise out of the water, and, whenever the speed becomes high enough, approximating to a certain relation with the square root of the length, portions of the keel may become visible. In extreme cases, it has even been found that as much as one-third of the length of the vessel has emerged from the water, and the tendency seems to be for the entire hull to climb up upon the surface. This has been noted in connection with the articles upon motor boats, appearing in our columns in 1906, from the pen of Professor Durand. It was stated by this authority in connection with this subject that there seems to be indication of "a marked decrease in displacement at these high speeds, a condition indicated also by observations on the boat itself under running conditions. It should be noted that, while such possibilities are plainly indicated for very high speeds, they must be purchased at some sacrifice of seaworthiness and weatherly qualities in rough water."

It goes almost without saying, that an investigation of this sort, giving results so totally at variance with what has heretofore been accepted as a normal condition of operation, will scarcely fail to exert a marked influence upon the design of vessels intended for the utilization of high speeds. Now that there is something definite known about the manner in which the enveloping medium traverses the length of the vessel, the form of the hull may undergo certain modifications to take advantage, so far as may be, of this action of the water. The results of long years of experience in the designing of hulls, however, have developed forms which are already probably not unsuited for the stream lines actually occurring in practice. The forms have been developed, however, without relation to a true knowledge of those stream lines, and, now that we have a beginning of such knowledge, it is more than possible that alert designers may make some marked modifications. The general form, however, will scarcely lend itself to much change, nor is such change very necessary, because we have already in many instances reached about the lowest limit of resistance under specific conditions of power and carrying capacity.

The other paper which we are publishing this month happens to be the first one read before this society which covers in any manner whatever the performance of marine turbines in service. The paper is extremely incomplete, by virtue of the great paucity of information in it, and it has been assailed from various sides as having many elements of incorrectness, in addition to its incompleteness. Nevertheless it has had a certain value in stimulating discussion and in bringing out facts and opinions from those who have had an opportunity to watch the performance of the vessel therein described.

One of the main criticisms of the paper lies in the curve between revolutions and speeds, which shows a tendency to become asymptotic at a speed of about 17½ knots, whereas the builders of the vessel had already tested her to a speed of about 19 knots, without developing any such tendency. It is more than likely that the discrepancy here noted lay in the devices for measuring speed, which, while faithfully recording speeds at all times during the run, yet at high speeds may have been so unsuited for this work as to have given erroneous results. The curve between power and revolutions runs up about as might have been expected, and the form of the hull is such as to make it practically out of the question to have such an extreme falling off in speed without some severe failing in some part of the mechanism, such, for instance, as the propellers. Numerous "points" were taken and plotted in determining this portion of the curve. The discrepancy cannot, therefore, be placed at the door of faulty or incomplete observations.

Be this as it may, we cannot but look with suspicion upon the indications of patent logs. They are extremely useful in many ways in recording speeds, etc.; but as an instrument for exact measurements, measurements upon which scientific deductions may safely be based, no device of this sort can be thoroughly relied upon. In one respect the patent log has an advantage over exact measurements between points, in that it automatically takes account of all tidal influences operating upon the waters through which the vessel is passing. This, however, is more than discounted by the ease with which such a piece of mechanism may get out of adjustment, while it is perfectly easy, with proper facilities, to take account of the flow of the tide over the course.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reported under date of November 9, 1907, the following percentage of completion of vessels building for the United States Navy:

	Tons.	Knots.		Oct. 1	Nov. 1
BATTLESHIPS.					
Mississippi......	13,000	17	Wm. Cramp & Sons.....	94.96	96.82
Idaho.........	13,000	17	Wm. Cramp & Sons.....	87.54	89.41
New Hampshire.	16,000	18	New York Shipbuilding Co...	85.3	90.2
South Carolina..	16,000	18½	Wm. Cramp & Sons..........	24.66	28.83
Michigan........	16,000	18½	New York Shipbuilding Co...	25.7	29.1
Delaware	20,000	21	Newport News S.B. & D.D.Co	0.66	2.33
North Dakota...	20,000	21	Fore River Shipbuilding Co..	0.00	4.23
ARMORED CRUISERS					
North Carolina..	14,500	22	Newport News Co...........	91.8	93.33
Montana........	14,500	22	Newport News Co...........	84.62	87.38
SCOUT CRUISERS.					
Chester.........	3,750	24	Bath Iron Works...........	90.64	92.7
Birmingham.....	3,750	24	Fore River Shipbuilding Co. .	89.46	90.79
Salem..........	3,750	24	Fore River Shipbuilding Co..	86.99	88.52
SUBMARINE TORPEDO BOATS.					
Cuttlefish.......	—	—	Fore River Shipbuilding Co...	99	99
Octopus........	—	—	Fore River Shipbuilding Co..	99.	99

ENGINEERING SPECIALTIES.

A Ship Lighting Set.

Messrs. W. Sisson & Co., Ltd., Gloucester, have placed on the market a ship-lighting set, consisting of a "Sisson" single-cylinder inclosed high-speed self-lubricating engine direct coupled to a dynamo. Electric lighting is now so much used on board ship, and the inclosed type of engine is coming into such favor with marine engineers that there is considerable demand for this type of engine, and a large number have been

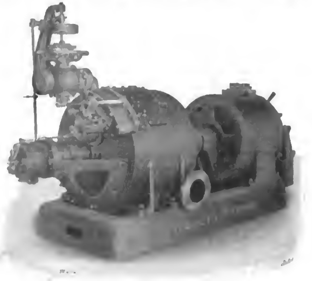
constructed for driving dynamos for ship lighting. An inclosed self-lubricating engine is, for obvious reasons, to be strongly recommended in preference to the open type; and this engine combines a neat appearance with compactness, simplicity, very easy access, good governing, ease of adjustment and economy in oil.

It embodies several features distinct from the general run of inclosed engines, for example, the governor is of patent crankshaft type, inclosed in the crank chamber, and automatically lubricated along with the other working parts. It controls the eccentric of the steam distribution valve, thus giving automatic expansion. It has a "throttling" action at low loads, and secures close regulation and good steam economy under varying loads. The connecting rod is so arranged that by one very simple operation, occupying a few moments only, both top and bottom bearings are adjusted to a nicety. The door is very large, light, and perfectly oil tight, is quickly removed and replaced, and gives ready access to the working parts of the engine.

Horizontal Curtis Turbine Generating Sets for Marine Service.

Until the attention of the public was called to marine turbine development by the recently built turbine-driven liners this source of power for marine use had hardly received its due amount of consideration. The construction of these liners calls attention to other turbine installations on shipboard, and directs the public gaze to the progress made in this line. The rapid development of electric drive, and the immense widening in the scope of electrical applications in marine service, require such an increasing amount of electrical power that engine-driven units of suitable size for general use aboard ship are coming to occupy altogether too much space. It is to meet these changing conditions that the steam engine is being displaced by the Curtis horizontal turbine, especially in lake service, where it is particularly valuable, both on account of its low head room and the high efficiency obtainable from condensing operation. In the illustration showing a complete 75-kilowatt set, the turbine is shown at the left, the generator being at the further end of the base. This cut also shows the throttle and governor.

Nowhere has the expansive force of steam been utilized to greater advantage than in the steam turbine. The directed kinetic energy of the steam is consumed in rapidly rotating a



large disk. The numerous small radial buckets set in the periphery of this disk present an enormous area to the entering steam, which strikes the buckets after passing through stationary inclined nozzles set in a plane tangent to the disk. The nozzles (see figure) are inclined in the direction of rotation of the disk, and at about 20 degrees to its plane, so that instead of entering from the end of the buckets, as the stream in a Pelton water-wheel, the flow enters at the sides.

On leaving the stationary nozzles, the steam passes through a small clearance space and impinges on the concave surface of the buckets, imparting a rotary motion to the disk. After leaving the movable buckets the direction of the steam flow

is so turned that, although still acting in a plane tangent to the disk, its direction is practically reversed. As the steam is still under considerable compression it is quite desirable to make use of its remaining energy by the use of another set of revolving buckets, or even by several more. The direction of flow being reversed by each set of movable buckets, it must be redirected each time, in order to be used on the next set.

While the clearance between blades is so small as to be almost negligible, there is absolutely no contact between stationary and rotating parts except at the shaft bearings. Simplicity was particularly sought after in the construction of the Curtis turbine generator, so that it requires a minimum of attendance. Oil is supplied to the bearings under slight pressure, but none enters into the turbine case, thus insuring

a perfect freedom from oil in the exhaust steam, allowing the latter to be used in a heating system, or returned direct to the boilers after condensation.

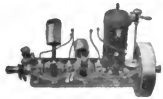
Horizontal Curtis turbine-driven units are now made in sizes from 15 to 300 kilowatts capacity. In the sizes up to 25 kilowatts, both generator and turbine are put on the same shaft, which runs in two bearings. Larger sizes are assembled on a two-part flexibly coupled shaft running in four bearings. At page 293 of our July (1907) number was shown one of these sets, of 25 kilowatts, on the Hudson River steamer *Hendrick Hudson*.

The turbine speed is governed by changing the number of nozzles through which the steam enters. This speed regulation is carried out by a centrifugal governor, which, mounted on the end of the turbine shaft, so varies the steam in-take as to give constant speed at all loads. Owing to the small weight, the turbine sets are easily installed, and as they are entirely free from reciprocating parts, require a foundation of but very moderate size and weight. They are supplied by the General Electric Company, Schenectady, N. Y.

The Ferro Marine Engine at the New York Show.

The Ferro, novel, interesting and the subject of lively comment as exhibited at each show last season, will reveal the same advanced ideas for which the Ferro Machine & Foundry Company, of Cleveland, is said in one year to have become prominent.

Entire absence of water pipes for conducting the water between cylinders, pump and discharge—great rigidity and

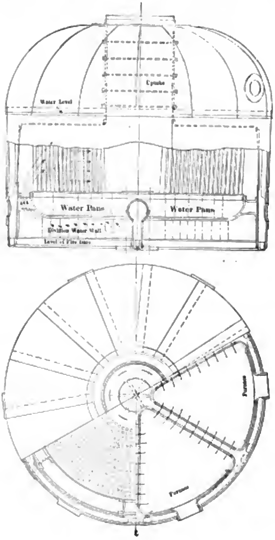


strength of construction, with cylinders supported on base independent of the crank shaft bearings, thereby eliminating transmission of undue stresses and strains between the various parts—pressure oiling system, in which all the oil is placed in one tank, and independently distributed without pumps automatically to each bearing surface; compact combined water-cooled in-take and exhaust header, especially designed for conveniently attaching exhaust connection to either air muffler, water muffler or submerged exhaust; sensitive timer adjusting lever to give instantaneous graduated speed changes in connection with carbureter throttle; wire seals on all bolted moving parts, replacing dangerous lock nuts; these, together with other details which can best be seen, should prove distinctive.

A working boat engine in a powerful 7½-horsepower single cylinder and 15-horsepower double cylinder, of great endurance and simplicity of parts and of a type claimed to have produced remarkable results during the past season in fishing, were also shown. In all, besides "Instruction Model," ten different sizes and various types of engines were exhibited, in horsepower from 1½ to 25, one, two and three cylinders, weights 38 pounds to ¼ ton, with and without boat, exhaust reverse gear, ignition and propeller equipments and accessories.

Haystack Boilers.

Two of the largest of these watertube boilers are being built by Hutson & Sons, Limited, Kelvinhaugh Engine Works, Glasgow, who make a specialty of this type. The object of the haystack boiler is to reduce weights so as to have with all contents a relatively small total weight in proportion to the power developed, and combined with these features the property of raising steam quickly. This is of prime importance in the paddle steamers, for which this



boiler has been so largely used. Successful examples of this type of boiler are very usual on Clyde river steamers, where a large number have these fitted, and also on many boats plying from Bristol Channel and South of England ports.

Probably no single watertube boiler possesses all the merits of an ideal boiler, and in nearly every case the attempt to gain certain advantages brings about corresponding disadvantages; but it is stated that (up to 120 pounds per square inch) the haystack boiler provides for ordinary pressures, good steaming and efficiency, which are absolutely indispensable, on a low weight. In many boilers the circulation is to a very great extent casual, but in a well designed haystack boiler it is systematic, the water entering through tubes at one end, and passing through in a continuous stream, being to a certain extent converted into steam as it goes. It will be seen from the illustrations that the heating surface is almost wholly composed of a series of vertical tubes up which the water circulates; these tubes are secured in the usual way, and serve to connect the top and bottom tube plates. Sometimes external down cast pipes are fitted on the sides of boiler to assist circulation, but it is doubtful if they are of any material advantage.

The builders give the actual weights of a boiler, including water and firebars complete, suitable for 2,500 horsepower, which works out at the rate of 74.5 pounds per indicated horsepower developed. Compared with this, ordinary boilers fitted with forced draft on the closed stokehold principle, for the same power, work out at 110 pounds per horsepower, showing a saving of weight on boilers alone of nearly 30 percent.

TECHNICAL PUBLICATIONS.

Bureau Veritas, 1907-1908; thirty-eighth year. General List of Merchant Shipping. Two volumes; steamers, size, 10 by 7½ inches. Pages, 1,700. Sailing vessels: size, 7¼ by 9¾ inches. Pages, 1,300. 1907. Paris: 8 Place de la Bourse. London: 155 Fenchurch street, E. C. Price of the complete work, £3-3s. ($15). Steamers, £1-15s. Sailing vessels, £1-10s.

This work requires no introduction, it being the regular list of all merchant vessels of the various maritime powers, with the usual particulars in the way of dimensions, powering, ownership, builders, etc. The books include also illustrations of the various types of vessels, together with tables showing the total tonnage and number of vessels of the various powers, as well as alphabetical lists of owners of fleets of vessels, with the respective tonnages. In addition to this, tables are given showing all the vessels under the several flags, arranged in order of signal letters. At the end of the volume of steamers is given a table showing all the drydocks, patent slips, floating drydocks and marine railways in all the ports of the world. There are also alphabetical lists of steamers arranged according to tonnage, under several sub-divisions, but including no vessels of under 600 tons. No less than 114 steamers of over 10,000 tons are here included, of which nine exceed 20,000 tons each.

Nautische Bibliothek. Size, 5 by 7½ inches. Three volumes. Berlin, 1907. K. W. Mecklenburg. Price, 1.50 marks (6s.) per volume.

Volume I. (90 pages): The Position of the Ship Officer in the Merchant Marine. By Dr. F. Bolte, Director of the School of Navigation in Hamburg. The work is based entirely on German practice, and describes, among other things, the school of seamanship in Hamburg, the North German Lloyd cadet schoolship and various private schoolships for fitting young men for the higher ranks in the operation of seagoing ships. This volume takes up the various conditions to be observed in connection with entering the service through the navigation and seamanship schools, and treats also of the position of the cadets with regard to military service.

Volume II. (125 pages): The Cadet Service. By Captain G. Reinicke. This volume includes a number of illustrations of the various parts of a ship and her rigging, together with the compass, and details of sails. The work is full of advice for the young man starting in on a seafaring career, chapters being given covering the first day of work, the departure from port, the watch, the first day at sea, loading and unloading, and particulars concerning service in various oceans and under various conditions. The appendix treats of the rations and the sanitary requirements on shipboard, besides giving a table of measures commonly in use.

Volume III. (pages 122; figures 32; tables 10): Elementary Navigation. By Dr. F. Bolte. This includes coastwise and deep sea navigation, with astronomical observations and the reckoning of latitude and longitude. The appendix deals with Mercator's projection, the influence of the ship's mechanism upon the compass, triangulation and various features dealing with the use of instruments. The tables cover tangents and corrections for refraction, parallax, etc.

Transactions of the Institution of Naval Architects for 1907. Volume XLIX. Edited by R. W. Dana, M. A. Size, 8½ by 11 inches. Pages, 334 + LII.; folding plates, XLII.

In addition to the list of officers and members of the Institution and the by-laws and regulations, there are found in this number the papers read at the spring meetings in London, in March, and at the summer meeting in Bordeaux in June. The best indication as to the contents lies in a list of the papers, as follows:

The Influence of Machinery on the Gun Power of the Modern Warship; Safe Submarine Vessels and the Future of the Art; On Some Points of Interest in Connection with the Design, Building and Launching of the *Lusitania;* The Evolution of the Modern Cargo Steamer; Cranes for Shipbuilding Berths; Torsiometers as Applied to the Measurement of Power in Turbines and Reciprocating Engines; Torque of Propeller Shafting—Some Investigations and Results; Propeller Struts; Experiments with Dr. Schlick's Gyroscopic Apparatus for Steadying Ships; Approximate Formulæ for Determining the Resistance of Ships; The Application of the Integraph to Some Ship Calculations; The Causes and Prevention of Fire at Sea; Modern Floating Docks; Some Phases of the Fuel Question; Some Practical Points in the Application of the Marine Steam Turbine; Structural Development in British Merchant Ships; Further Results of Submarine Signaling by Means of Sound; On the Use of Hydraulic Riveting in the Construction of the *Mauretania.*

The frontispiece is a photogravure of Sir Edward J. Reed, K. C. B., F. R. S., who was at one time naval construction director of the Admiralty.

The Mechanical World Pocket Diary and Year Book for 1908. Twenty-first annual issue. Size, 4 by 6 inches. Pages, 391. Figures, 57. Manchester: Emmott & Company, Ltd. Price, 6d. net.

Within a small compass, in a book conveniently carried in the pocket, have been collected a large number of tables of engineering data of all descriptions, from the usual mathematical and trigonometrical tables to horsepower, steam and vacua tables, tables of the properties of I and Z-bars, shafting and the strength of materials, electrical constants and wiring tables, hydraulic data, tables of bolts, nuts and threads, conversion tables between metric measures and the corresponding British units—in short, all of the usual data and tables to be found in the general engineering reference books. In addition to this are to be found many "chapters" or notes on various subjects

of an engineering character, such as engines, boilers, valve setting, pumps, oil and gas engines, belt and rope driving, electric machinery, power transmission and devices, and a multitude of other items of interest to the engineer.

In the rear of the book are a diary and blank pages for memoranda. A splendid and very complete index renders the book exceedingly easy of access, and adds enormously to its value as a work of ready reference.

The Use of the National Forests. By Gifford Pinchot. Size, 5 by 7 inches. Pages, 42. Half tone plates, 7. Washington, 1907. United States Department of Agriculture.

This little book was designed to explain just what the national forests of the United States are, what they are for and how they should be used. It is not a treatise on forestry, but it gives good practical advice as to what not to do in the conduct of large stretches of timberland. The questions of the water supply, the fire hazard, the proper cutting of timber, and the use of the land for grazing purposes, where the trees are sufficiently open to allow this, are among the topics discussed in the book. At the end is a list showing the size of the various forest preserves in the United States on April 1, 1907, the aggregate of 150 forests or public parks being about 143,000,000 acres (223,100 square miles). The largest single unit in this immense total is the Yellowstone National Park, which contains 8,317,880 acres. The state with the largest representation is California, which has nearly 22,000,000 acres, but Idaho and Montana are close behind, with more than 20,000,000 acres each.

It will be noted that the total acreage of these forests is much greater than the entire area of either France or Germany, and that it is nearly twice as great as the area of Italy or of the United Kingdom.

Hydraulics. By S. Dunkerley, D. Sc. Size, 5½ by 8½ inches. Pages, 343. Figures, 269. London and New York: Longmans, Green & Company. Price, 10/6 net; $3.

This is the first of two volumes on the subject of hydraulics, and covers hydraulic machinery. The second volume, which has not yet appeared, is devoted to the resistance and propulsion of ships. The present volume is based on lectures on hydraulic machinery given in the course for engineers and constructors at the Royal Naval College, Greenwich, and is intended as a text book for use in universities and the royal navy, as well as for designers of hydraulic machinery.

The work is divided into seven chapters, followed by a set of examples and an index. The chapters deal respectively with the flow of a perfect fluid; fluid friction; pressure machines; reciprocating pumps; hydraulic turbines; centrifugal pumps, and the researches of Prof. Osborne Reynolds upon viscosity, sinuosity, eddies, resistance in tubes and lubrication.

The illustrations are nearly all line cuts, and serve to render the text easily readable, and to explain its meaning thoroughly. The first part of each chapter is taken up with theoretical considerations, the principles being developed without the use of calculus; while the second section takes up machines and devices for the production or application of hydraulic power, with copious illustrations. Among the most interesting items from the point of view of the marine engineer are discussions on hydraulic riveters, hydraulically operated bulkhead doors, hydraulic cranes and brakes and other devices for the operation of heavy guns on shipboard. The reciprocating, turbine and centrifugal pumps are also interesting, and are given in much detail.

Omission.—The mine-laying steamer *Capt. A. M. Wetherill*, described at page 502 in our December number, was built by the T. S. Marvel Shipbuilding Company, Newburg, N. Y.

QUERIES AND ANSWERS.

Questions concerning marine engineering will be answered by the Editor in this column. Each communication must bear the name and address of the writer.

Q. 387.—On page 458 of your issue for November is the statement that the index n in the expression $H_1:H_2::V_1^n:V_2^n$ is very high, and that this index, which is often assumed as 3, becomes 4.68 for the *Democratie* and 6.98 for the *Justice*. What does this mean, and how do you get these results? N. S. Y.

A.—It has long been known that in order to increase the speed of a ship, it would be necessary to increase the power in a much higher ratio than the increase of speed desired. Experiments have shown that under ordinary conditions, and for a speed not excessive for the size and type of ship under consideration, the power would increase about as the cube of the speed. This means that if we are going to double the speed, we will have to supply eight times the power required for the lower speed; and similarly for other proportions of increase in speed. To express this algebraically, $H = aV^n$, where H represents the horsepower, V represents the speed in knots, a represents some coefficient, which will vary for different ships, but will be approximately constant for any one ship under conditions which are not abnormal, and n is the index of the power of the speed, according to which the horsepower varies. As stated above, this index is usually taken as 3; that is to say, it is usually assumed that the horsepower required will vary as the cube of the speed.

For the particular instance in question, however, this index does not fit the case. We might make a table, showing the various points involved, as follows:

	Démocratie.	*Justice.*
V_1	17.39	17.94
V_2	19.44	19.43
H_1	11,472.	11,520.
H_2	19,190.	18,548.
$V_2:V_1$	1.1179	1.0831
$H_2:H_1$	1.6668	1.6109

It will be noticed that V_1 represents what we have termed the "intermediate speed" of the vessel in knots; V_2 represents the highest speed; H_1 represents the horsepower required for the intermediate speed; and H_2 the horsepower required for the highest speed.

It will also be noticed that the ratio of increase in the horsepower $(H_2:H_1)$ is much greater than the ratio in speed $(V_2:V_1)$. The most convenient way to obtain the index of the power according to which these vary is by the use of logarithms as follows:

Log. $V_2:V_1$	0.04840	0.03467
Log. $H_2:H_1$	0.22189	0.20707

By dividing log. $H_2:H_1$ by log. $V_2:V_1$, we obtain the index required. This is 4.58 for the *Démocratie*, and 5.98 for the *Justice*, as mentioned in our November number.

Q. 388.—Kindly give me some information on lining up a steeple compound tugboat engine, the main bearings of which have worn until the engine shaft is quite low. As the shaft has no spring bearings, I don't know how much to raise the shaft, for it is impossible to put the boat in dry-dock and remove the shaft, to run a line through the stern tube. Shaft is about 10 inches in diameter. M. C. M.

A.—There are three methods which appear available under certain conditions:

(1) If the original clearance at the upper end of the upper cylinder is known, that cylinder cover could be taken off and the engine turned until the piston reaches the top of the stroke. The present clearance could then be noted, and adjustment of the main bearings could be made until the clearance is brought to the old figure.

(2) In case the original clearance is not known, and the line shafting has retained its alinement, it would be possible to run a straight line by means of a very taut wire parallel to this

line shafting, and through the engine in such a way that the position of this wire with regard to the axis of the line shafting could be compared with the position of the wire with regard to the crank shaft in the forward bearing. This bearing is the one which has probably suffered most in wearing down, and is, therefore, the one where best results would be obtained in the way of observation, as above outlined. Unless the wire is stretched very tight, however, it will be unreliable as a basis for comparison, and it will have to be so placed as to be *exactly parallel* to the portion of the shafting which has not got out of alinement.

(3) If neither of these methods can be used by virtue of there being no portion of the shafting upon which reliance can be placed, there seems to be still another method left, provided the original drawings of the engine can be obtained. These drawings would show the position of the center of crank shaft with regard to some finished surface on the bedplate, or, with regard to some finished surface at the bottom of the cylinder. Direct measurements could then be made, and the defect remedied in accordance with results thus obtained.

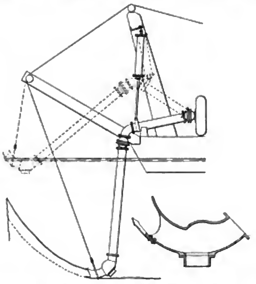
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

867,492. HYDRAULIC DREDGE. CHARLES A. FRAYER, MILWAUKEE, WIS., ASSIGNOR TO ALLIS-CHALMERS COMPANY, MILWAUKEE.

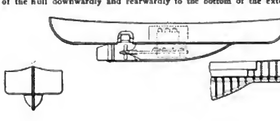
Claim.—1. In a hydraulic dredge, a shovel, a hollow arm therefor



for conveying away material dug by the shovel, a separate water inlet for the hollow arm, and a recess within the arm opposite the water inlet.—Four claims.

867,654. HULL FOR VESSELS. SAMUEL GOLDEN, BUFFALO, N. Y.

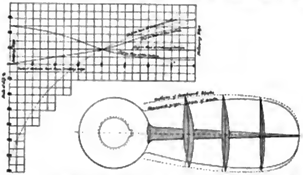
Claim.—The combination of a vessel hull having a hollow horizontal bottom extension of less length and width than the hull, said extension being overhung by the bottom of the hull at the front, rear and sides, the front portion of the extension sloping from the bottom of the hull downwardly and rearwardly to the bottom of the extension,



the front and rear ends of the extension being arranged at a distance rearwardly and forwardly of the front and rear ends of the hull, and the bottom of the hull extending approximately at right angles outwardly from the upper ends of the sides of the extension, a propelling engine arranged with its lower portion in the extension, a horizontal propeller shaft extending from engine rearwardly through the extension, a propeller arranged at the rear end of said extension, and a rudder arranged in rear of propeller, underneath the overhanging bottom of the rear portion of the hull. One claim.

867,858. SCREW PROPELLER. DAVID W. TAYLOR, WASHINGTON, D. C.

Claim.—1. A propeller blade whose developed section is derived from a curved directrix extending from the forward or leading part of the



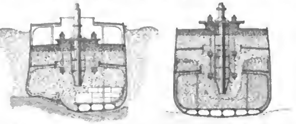
blade to the following edge, the blade having the forward half of its back parallel to said directrix, the rear halves of the back and face of the blade converging to meet the directrix at the following edge and the forward half of the face of the blade determined from the thickness of the section and the curved back of the blade.

3. A propeller blade, the rear halves of whose developed sections are symmetrical to a curved directing surface of axially increasing pitch, and constant radial pitch.

7. A propeller blade the thickness of any section of which at any point of its rear half is proportionally distributed on both sides of a curved directrix, the whole thickness of the blade section at such point being proportional to the ordinates of a curve of sines plotted upon the length of the entire section, which length is taken to represent 180 degrees. Seven claims.

867,983. MEANS AND APPARATUS FOR RAISING SUNKEN VESSELS. SIMON LAKE, BRIDGEPORT, CONN.

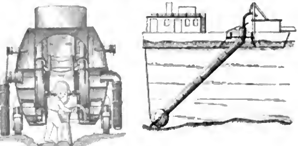
Abstract.—The invention consists broadly in displacing the water in the interior of a sunken vessel by pumping buoyant material, either solid or capable of being solidified, into the vessel until the dead weight of the vessel, its fittings and cargo are overcome by such



material. The buoyant material preferably is cork, in the form of blocks of a size that can be readily handled in a centrifugal or other force pump, the cork being first coated or boiled in paraffin or other suitable substance to make it more impervious to water, and in cases where the decks of the vessel are weak and liable to lift, a suitable buoyant compound, such as a mixture of paraffin and cork, is preferred. This can be readily pumped, it solidifies in water, and after being forced into the vessel it will, through its buoyancy, readily seek the under surface of the decks and the sides of the vessel, and becoming hard will form a light, solid body that will strengthen the deck. Twenty-one claims.

867,984. DREDGING APPARATUS. SIMON LAKE, BRIDGEPORT, CONN.

Abstract.—The invention comprises a submergible tube, having its lower end terminating in a casing forming a working chamber, with

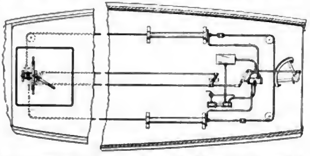


which is connected suction apparatus employed for collecting the gold, sand and gravel and delivering it into separating chambers, where the gold is separated from the sand and gravel, and the sand and gravel finally discharged back into the body of water. Supplemental means

are employed for assisting the suction apparatus in lifting the gold, sand, gravel and water. Means are employed within the working chamber, capable of being operated independently of the suction apparatus, for collecting the gold located in small crevices and in places where the larger pipes cannot work. Thirty-five claims.

868,160. HYDRAULIC STEERING APPARATUS. HART S. DE PUY, SEATTLE, WASH.

Claim.—1. In steering apparatus, the combination with the rudder post and a tiller line of a power cylinder, a piston within the cylinder,



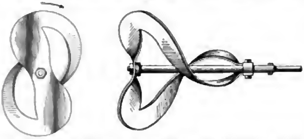
devices upon the said line whereby the line is operatively engaged by the piston when the latter is actuated by a power medium to move in one direction, and to engage the piston and move the same when the tiller line is moved in the opposite direction, and means to control the admission or escape of said power medium. Four claims.

868,199. PROPULSION OF BOATS OR VESSELS. JOHN H. LORIMER, PHILADELPHIA, PA.

Claim.—1. The means for propelling vessels by discharging under great pressure a large number of continuous fluid streams through narrow orifices arranged in series extending longitudinally of the vessel, the orifices in one series being in staggered relation to the orifices in the adjacent series, each stream discharging independently and without interference with the other streams, or the fluid of flotation under such other streams affected thereby, so as to utilize substantially all the velocity of the streams at the edges of the orifices. Two claims.

868,220. PROPELLER. JULIAN PORTELLI AND JOSEPH D. CHAPMAN, LOS ANGELES, CAL.

Claim.—1. A propeller comprising a shaft, a plate fixed at its longi-



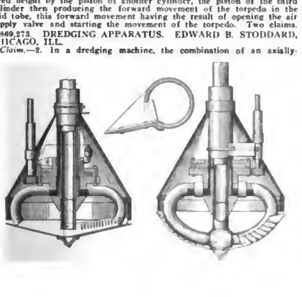
tudinal center to said shaft, said plate being bent laterally in opposite directions and having forwardly extending spiral wings, the ends of which are fastened to said shaft.—Three claims.

868,946. TORPEDO PROJECTING APPARATUS FOR SUBMARINE AND SUBMERSIBLE VESSELS. HENRI SMULDERS, SCHIEDAM, ROTTERDAM, NETHERLANDS.

Claim.—2. A torpedo projecting apparatus for submarine and submersible vessels, comprising a tube, three cylinders, piping adapted to form communication between the said cylinders, a supply of fluid under pressure adapted to communicate with the first cylinder, and an arresting device such that the piston of one cylinder releases the said arresting device as soon as the apparatus has been raised to the desired height by the piston of another cylinder, the piston of the third cylinder then producing the forward movement of the torpedo in the said tube, this forward movement having the result of opening the air supply valve and starting the movement of the torpedo. Two claims.

869,273. DREDGING APPARATUS. EDWARD B. STODDARD, CHICAGO, ILL.

Claim.—2. In a dredging machine, the combination of an axially-



disposed intake, one or more feeding arms arranged to rotate about said intake, means for rotating said arms, excavating blades for excavating material in advance of said arms, and means for directing water through said arms toward said intake. Seventeen claims.

869,180. YIELDING BOAT-CLEAT. FREDERICK A. BIERIE, PHILADELPHIA, PA.

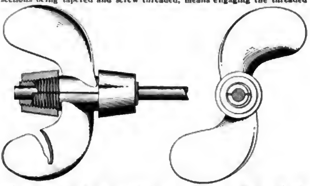
Claim.—1. A boat-cleat comprising a base, post and T-head, and yielding means arranged in the head, provided with rope-attaching means. Four claims.

869,399. ADJUSTABLE TOP FOR LAUNCHES. WALTER P. WALTER, STAMFORD, CONN.

Claim.—2. The combination with the combing of a launch, of a vertically movable top having a depending flange inclosing the combing in its lowered position, folding standards by which the top may be retained in the raised position, and offset supports on the combing by which the front standards are held against swinging forward, and the rear standards against swinging backward. Seven claims.

870,136. PROPELLER WHEEL. ROBERT W. SHAW, STAMFORD, CONN.

Claim.—2. A propeller comprising a sectional hub, the ends of said sections being tapered and screw threaded, means engaging the threaded



ends of the sections for clamping the same upon a shaft, and outwardly inclined blades disposed diagonally to the axis of the hub, each blade being concavo-convex in section. Two claims.

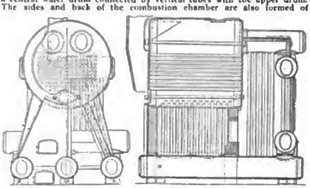
870,235. DEEP-WATER GOLD DREDGE. WARDELL GUTHRIE, CHICAGO, ILL.

Claim.—4. In a gold dredge, the combination with a float, of hydraulic dredging means adapted to be raised and lowered, hoisting mechanism arranged to act upon the said dredging means, a plurality of buckets, and hoisting devices and tackle arranged to raise and lower the said buckets adjacent to the said dredging means. Seven claims.

British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

10,111. STEAM GENERATORS. COMPOSITE BOILERS. L. TAYLOR, SALTBURNE-BY-THE-SEA.

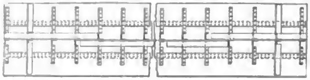
An upper steam and water drum, traversed by smoke tubes, is connected with water drums at the sides of the grate by two rows of tubes, which serve as uptake and downtake tubes respectively. There may be a central water drum connected by vertical tubes with the upper drum. The sides and back of the combustion chamber are also formed of



double rows of tubes, which communicate above with extensions of the drum, and below with the water drums; the tubes are connected to intermediate transverse drums. Two boilers may be placed back to back to form a double-ended boiler.

10,262. SHIPS' KEELSONS. R. E. ELLIS, OF D. & W. HENDERSON & CO., PARTICK, GLASGOW.

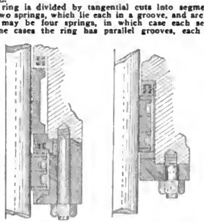
The center girder of double bottoms is constructed with its upper and lower edges either flanged or fitted with an angle bar. The angle bars or flanges are arranged on opposite sides of consecutive portions of the girder, so that efficient and strong connections may be made. This



construction enables the keelsons to be built up from templets, and to be riveted up before being put in place. In a modification, the flanges or angle bars are on the same side on consecutive plates, and the butts are strengthened by short angle bars.

10,023.—STUFFING BOXES. J. B. L. ROBSON, NEWCASTLE-UPON-TYNE.

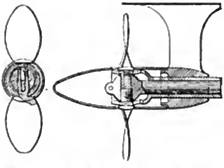
A packing ring is divided by tangential cuts into segments braced together by two springs, which lie each in a groove, and are secured to pins. There may be four springs, in which case each segment has pins. In some cases the ring has parallel grooves, each containing



springs. In one arrangement of this packing two rings with washers and a compound ring containing springs for axial adjustment are contained in a box, supplied with lubricant by a passage. The rod is further packed by a grooved sleeve adjusted axially by springs.

10,491. SCREW PROPELLERS. W. AND V. LORENC, BERLIN, GERMANY.

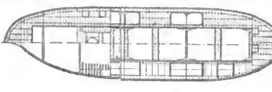
The blades of screw propellers are supported in pairs situated in the same plane. The shank of one blade is mounted in the shank of the opposite blade, which itself is mounted in the hub. By this method, the blade shanks may be made of great length without increasing the diameter of the boss. The blades are preferably secured by screwing

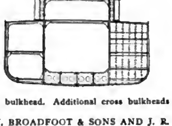


one into the other, and this method of construction is specially applicable to feathering screw propellers. The blades are feathered by sliding the boss longitudinally within the hollow shaft, which is provided with curved slots engaging with squared surfaces on the blade shanks.

11,078. SHIPS' BULKHEADS AND TANKS. J. H. ZEEMAN, THE HAGUE, HOLLAND.

A ship is divided into three holds by two longitudinal bulkheads extending above the upper deck, and continuously from the forepeak

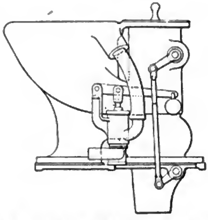




cross bulkhead to a stern cross bulkhead. Additional cross bulkheads may also be fitted.

11,526. SHIPS' CLOSETS. J. BROADFOOT & SONS AND J. R. APPLEBY, PARTICK, GLASGOW.

In closets of the type in which two valves are used, one being closed while the other is open, a handled rod is connected directly to the upper valve, and the spindles of the valves are connected by links. Through a slot in the vertical link passes a weighted lever pivoted to a



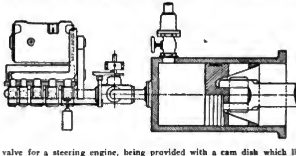
bracket and the spindle of the flushing valve. When, therefore, the upper valve is opened by raising the handle, the flushing valve is opened and a flush delivered. The flushing valve is not quite closed when the upper valve reaches its seat, so that an afterflush is delivered during the time that the weighted lever continues its descent.

12,151. SHIPS. J. CANARD, PARIS, FRANCE.

Vessels are constructed with an inner as well as an outer skin, and the space between the skins is filled with a number of cells containing air or other gas, or cork, pine-soot, or the like. A buoyant structure is thus formed. In addition, the cells may be fitted in all vacant spaces in the ship, such as between the planks or timbers of decks, bulkheads, and the like. The cells may be made of india rubber or metal.

12,335. STEERING GEAR. SIEMENS BROS. & CO., WESTMINSTER, LONDON, AND H. WRIGHT.

Two or more hydraulic rams, fed by a number of pumps, operate the tiller rods. The pumps may be put in or out of operation as the load varies during the movement of the rudder by a device for throwing their valves out of action, or by a by-pass. By this means, the motor driving the pumps may run continuously, but the invention is not confined to apparatus in which this occurs. The control valve for the hydraulic rams may be operated in the same way as an ordinary control



valve for a steering engine, being provided with a cam dish which lifts the suction valves of the pumps when it is at or near its mid position.

13,086. SHIPS' BULKHEAD DOORS. L. C. F. GUEMBEL.

Relates to apparatus for simultaneously opening and closing bulkhead doors hydraulically from a central station, the water under pressure led to the hydraulic cylinders for the different doors being regulated from a single reversing cock. The controlling mechanism for the individual doors, which allows them to be opened or closed locally, consists of a piston provided with waterways and capable of being reciprocated in a cylinder by means of a hand lever. The cock on the bridges is connected with a water-pressure reservoir and a waste-water tank, and with each separate door by pipes. A peg locks a hand lever and keeps the piston at the bottom of the cylinder. When the doors are opened from the bridge, and it is desired to close one door locally, the peg is removed, so that the piston is forced up, the pressure is reversed in the cylinder, and the door closes. When the lever is brought back to its former position, the door opens.

13,859. INDICATING POSITION OF SUNKEN SHIPS. H. SCHWAB, PARIS, FRANCE.

An inflatable buoy for indicating the position of sunken vessels, *e. g.*, submarine torpedo boats, is deflated, folded and placed within a chamber of a suitable vessel, which also contains a gas generator. Water passes into the latter, upon immersion, through a valve and acts upon carbide in a cylinder. The valve is gradually closed by the pressure exerted upon the perforated diaphragm, and the top of the buoy or balloon is forced along the tube until it lifts the end, when the buoy expands into the water, its lower end being rigidly attached to the tube. A relief valve is provided at the top of the buoy, and it may be combined with a whistle or siren and with a self-lighting burner.

14,016. BARGES; BULKHEAD DOORS. S. WATKINS, LONDON.

In lighters or vessels from which coal or other material is discharged by means of continuous conveyors through doors at opposite sides of a tunnel, a platform is provided in the tunnel so that a person may readily observe the discharge of the cargo, and easily operate either of the doors should it become blocked with a large piece of material. The doors are held against the sides of the tunnel by rollers, carried either on the doors or their frames. Each door is fitted with a vertical rack, with the teeth of which a bar may be engaged. Pivoted weighted pawls maintain the doors in the desired position, and the pins upon which the pawls turn are utilized as fulcrums for the bar.

International Marine Engineering

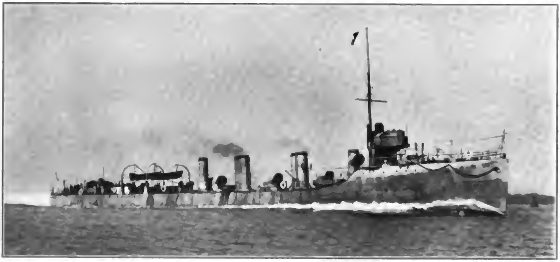
FEBRUARY, 1908.

THE FASTEST SHIPS IN THE WORLD.

At the beginning of every year it is customary to review the progress made in shipbuilding during the previous twelve months, and by picking out the salient features of each contributory line of evolution to strive to form the best idea of the directions of greatest progress or the tendencies of future development. Two facts stand out at present above all others. The first, affecting merchant steamers alone, is the enormous improvement in the comfort and luxury of ocean voyaging; the second, with which we are now concerned, is the great rise in absolute speed which, though very marked in special cases in the mercantile marine, is much more general in the warships of the world. It is, however, impossible to form any opinion of value by simply considering the progress of one particular year, and we propose to deal with the growth in speed since the beginning of the century.

It is a very simple matter—given the money—to produce a small vessel of abnormal speed. Cases such as the famous *Arrow* or the *Turbinia*, in which absolutely everything is sacrificed to pace, do not represent by any means the acme of naval architecture. Interesting they certainly are, but their use and value are doubtful and transitory. When, however, it becomes a question of attaining not only a very high speed, but of *maintaining* it, and of carrying weight in addition, be it cargo or coal, guns or armor, the problem becomes different and more difficult, while if, in addition to this, the vessel must be commercially profitable, the conditions become extremely hard to fulfil. The case of the recent Cunard vessels is one of the most up-to-date examples available. In warships, of course, the question of cost hardly enters, and use can be made of designs or materials that dividend earning concerns could not afford, and in which at the same time there is neither the need nor the inclination to take the risks or reduce the margins that are accepted in naval work. The two cases must therefore be treated separately.

For a floating ship-shaped body propelled on the surface of the water speed has also a relative value, the real measure being its ratio to the square root of the length, viz.: $\frac{V}{\sqrt{L}}$ where V is speed in knots and L is length in feet. In cases where the value lies between 0.5 and 0.7 the ship is being driven at a very moderate and economical speed; between 0.7 and 1.0 we find the speed of mail steamers and battleships, and between 1.0 and 1.3 we get cruisers and channel steamers. Beyond 1.35 we cannot go in full sized vessels under present conditions, because it is not possible to get enough engine and boiler power into the ships, on account of the fact that the floor space available in the ships is not sufficient; but it can be done in torpedo craft by using very high-speed engines and excessive forced draft to the boilers. In these ships the ratio of $\frac{V}{\sqrt{L}}$ is between 1.8 and 2.2, and only in very exceptional cases has the latter ratio yet been exceeded. The reason underlying the importance of this ratio is that the wave-making resistance of the ship does not increase regularly, but in humps of varying magnitude, the first of which occurs at a speed of about 1.4 to 1.6 times $\sqrt{L}$. From the above it follows that speed should always be considered relatively as well as absolutely.



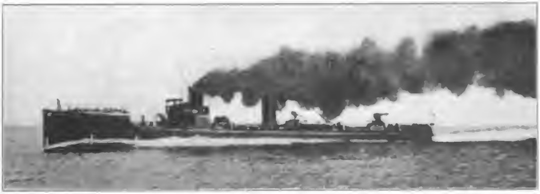
BRITISH TURBINE-DRIVEN DESTROYER MOHAWK, STEAMING AT OVER 34 KNOTS ON OFFICIAL TRIAL TRIP.

WARSHIP SPEEDS.

One of the earliest and relatively fastest vessels built was the *Forban* of the French navy, which was constructed by

Normand at Havre in 1895. She attained 31.2 knots, though only 144 feet long, displacing 125 tons and requiring 3,950 I. H. P. For some years she held the record for speed, and was always a remarkable vessel, her success being almost entirely due to her exceptional machinery. The *Turbinia*, early in 1897, was the first vessel to break the *Forban's* record. Up to 1900, about eighty vessels had been built which had, on genuine official trials, attained a speed of 30 knots. Sixty of these were in the navies of England (48) and Japan (12). They were all propelled by reciprocating engines, and for the most part averaged from 210 to 215 feet in length by 20 to 22 feet breadth. The power was about 6,500 I. H. P.

In 1900, however, the trials of H. M. S. *Viper* astonished everyone. This vessel still holds the record for speed, having attained over 37 knots when displacing 370 tons. She was of exactly the same dimensions as the 30-knotters, but with larger boilers—having 275 square feet of grate area, compared with about 220 in the other ships, the respective heating surfaces being 15,000 and 12,000 square feet. The *Viper* was the first vessel to be fitted with Parsons turbines (except the *Turbinia*), and the results of her trials are given in Table I. The turbines weighed about 7½ percent less than the reciprocating engines of only half the power fitted in the sister ships.



THE GERMAN TURBINE-PROPELLED TORPEDO BOAT DESTROYER G137 AT HIGH SPEED.

TABLE I.

Trial	Speed in Knots	Equivalent I. H. P.	R. P. M	Coal Burned per Hour. Pounds.	
				Total	Per I.H.P.
Maximum power (1 hour)	37 113 max. / 36 58 mean	13,000	1,180	34,500	2 61
3-hour coal consumption	33 83	10,300	1,050	25,700	2 49
3-hour official trial	31 118	8,350	950	19,800	2 38
12-hour slow speed	15 0	750	450	3,000	4 03

The *Viper* was lost by running ashore, and the *Cobra*, a very similar vessel of slightly slower speed, broke her back through structural weakness and sank in the North Sea. The loss of the *Cobra*, coupled with signs of weakness in many of the 30-knotters, resulted in a change of policy in the construction of these high-speed vessels, and structurally heavier hulls were afterwards required, the consequent sacrifice in speed being accepted. In England, therefore, between 1901 and 1905 no really fast destroyers were build for the British navy. One exceptionally fast vessel, the *Mode*, was built by Yarrow for the Swedish government in 1902, a speed of 32.4 knots being obtained; but in other navies no attempt was made to exceed 30 knots—in fact, Germany was content with 27 knots and France and Italy with about 28. Until this year hardly any new torpedo craft have been constructed in the United States for some years.

Towards the end of 1905, however, the British Admiralty laid down five ocean-going destroyers, most of which have just completed their trials. These vessels and the subsequent batches of two laid down in 1906 and five in 1907 are all about 250 to 280 feet long, and displace about 850 tons. The speeds attained on a six-hour trial have varied from 33.14 in the *Cossack* to 34.3 in the *Mohawk*, which latter at present holds the record for being the fastest ship afloat.* Propelled by Parsons turbines of about 17,000 horsepower, these vessels are very remarkable in many ways. They carry a poor armament (only three 12-pounders and two 18-inch torpedo tubes), but are especially built for sea-keeping in company with the fleet. They carry 160 tons of oil fuel.

Another remarkable vessel, *G137*, was completed in 1907 by the Germania Company, at Kiel. Also propelled by turbines, *G137* is extremely similar to the British river class boats of 26 knots speed that were built in 1903 and 1904. She attained a speed of 33.1 knots on her trials at 580 tons displacement, and carries no less than four torpedo tubes, one 15-pounder and four smaller guns.

The extraordinary success that attended the speed trials of all these very fast vessels of 1907 has gone a long way to assure naval architects of the success of H. M. S. *Swift*, which is by far the most remarkable ship now under construction, from the speed point of view. Built for a speed of 36 knots on an eight-hour trial under service conditions, the vessel displaces no less than 1,800 tons on 10-foot 6-inch draft. The armament will include four 4-inch guns. The ship was launched on Dec. 7, 1907.

Table II. shows the leading dimensions and speeds of all these vessels, together with the dates of their trials. The years 1903, 1904, 1905 and 1906 do not show any progress of importance, 30 knots being the extreme speed attained, and most navies contenting themselves with slower vessels of more durable construction. The performance of *G137* is remarkable in that it was attained with coal fuel. Oil fuel seems likely to become an absolute essential in the design of these very fast craft, for it admits of several advantages which cannot be ignored.

(1) Greater calorific value, giving either greater radius of action on same weight of fuel, or less weight for same radius.

(2) Greatly reduced stokehold space required, especially in a fore-and-aft direction.

(3) Greater ease of manipulation.

It is interesting to note how the length of these vessels has increased in proportion to the speed; the ratio has remained very constant during the last seven years.

In all these cases we have considered vessels of abnormal absolute speed, in which great sacrifices of armament and protection have been made to secure pace. We shall proceed next

* Eclipsed by the sister-boat *Tartar*, which, on Dec. 17, averaged 35.36 knots for 6 hours, and made 1 mile at the rate of 37.037 knots

to work back to vessels of the cruiser type, which are also relatively high-speed vessels. The first step in the connection is obviously through the *Scout* class of cruiser, and as it happens that these vessels are remarkably similar in general dimensions to the *Amethyst* type of third-class cruiser, we have compared these vessels in Table III., adding the most recent type of second-class cruiser. After this point in British naval practice there is a radical change. The size of vessels necessitates their being protected by external armor, and the necessary compromise of weights involves a reduction in machinery. We then begin to get to comparatively slow proportionate speeds. Thus, for instance, the very fast cruisers of the *Good Hope* and *County* classes of 500 and 440 feet in length, have speed-length ratios of only 1.075 and 1.1, respectively.

TABLE II.

Vessel	Date	Length feet	Speed, knots	$\frac{V}{\sqrt{L}}$	Horse-power	Dis-place-ment, Tons	Horse-power per Ton *D*	Admiralty Coefficient
[illegible]	1895	145	31.2	2.59	3,950	125	31.6	192
Turbinia	1897	100	33.0	3.3	2,300*	44.5	49.5	205
English Navy	'98-'00	210	30.0	2.07	6,500	320	20.3	194
Japanese Navy	1899	220	31.0	2.09	7,000	315	22.2	197
Viper	1900	210	37.0	2.55	13,000*	370	35.1	200
Mode	1902	220	32.4	2.175	7,500	400	18.8	246
G 137	1907	235	33.1	2.16	13,400*	580	23.1	188
Cossack†	1907	270	33.2	2.02	17,500*	830	21.1	185
Swift†	1908	345	36.0	1.94	33,000*	1,800	18.3	209

* Turbine machinery. † Oil fuel.

TABLE III.

Vessel	*Swift*	*Sentinel*	*Amethyst*	*Encounter*
Length	345′	360′	360′	355′
Breadth	35′	40′	40′	56′
Displacement	1,800	2,800	3,000	5,800
Speed	36	25.5	23.6 (21.75 design)	21.0
Horsepower	33,000	17,500	14,000 (10,000 design)	12,000
Armament	4 4-inch, 0 tubes	10-12 prs., 8-1½ prs., 2 tubes	12 4-inch, 8-3 prs., 2 tubes	11 6-inch, 9-12 prs., 2 tubes
Protection	nil	armored deck	armored deck	armored deck
Coal at normal draft	180 tons (Oil fuel)	150 tons	300 tons	500 tons
Date	1908	1905	1904	1902
$\frac{V}{\sqrt{L}}$	1.94	1.341	1.215	t.13

An Electrically Operated Sea-Going Steam Dredge.

The seagoing steam dredge *Thor* is the first instance of a dredge designed for purely electrical operation of all winches and mechanisms, inclusive of the bucket drive. It has been constructed on plans by Mr. W. Meiners, while the electrical part was supplied by the Siemens-Schuckert Works.

The *Thor* is used at the mouth of the river Weichsel as a bucket dredge for pontoon and floating operation. Its output is 170 cubic meters (222 cubic yards) of dredging ground per hour, the maximum depth of dredging being 8 meters (26 feet), and the traveling speed 12 kilometers (7.45 miles) per hour (6½ knots). The length is 44.5 meters (146 feet), breadth across frames 8.5 meters (28 feet), depth amidships 3.3 meters (10 feet 10 inches), and draft in full working order 2.16 meters (7 feet 1 inch).

The boiler and engine rooms are situated amidships, and the rooms reserved for the crew, as well as the chain and utensil compartments, in the bow and stern. On the deck there are located the chart room and kitchen, with the pilot's cabin on top of the latter, while the deck houses are situated sideways. Both petroleum and electrical lighting have been provided, and all the rooms are ventilated efficiently.

The boiler plant comprises two horizontal fire-tube boilers with return tubes, designed for a pressure of 9 atmospheres (132 pounds per square inch), and a combined heating surface of 180 square meters (1,937 square feet). Two steam engines of 175 horsepower each, running at 185 revolutions per minute, serve to operate the propellers and centrifugal pumps, while a third steam engine, of 220 horsepower output at 350 revolutions per minute, is directly coupled on the one hand to a continuous current shunt dynamo, with reversing poles, of 82 kilowatt output and a tension of 10 to 110 volts at the terminals, for operating the upper tumbler; and on the other hand to a direct current compound wound dynamo of 46 kilowatts and 110 volts, for operating the various winches, while serving at the same time as exciter machine for the other dynamo (Fig. 2). A fourth steam engine of the Deaval type, of an output of 25 horsepower at 500 revolutions per minute, is coupled to a 12.4-kilowatt direct current shunt dynamo with a tension of 110 volts at the terminals, which is intended for supplying the electric lighting plant.

The four steam engines referred to are provided with a

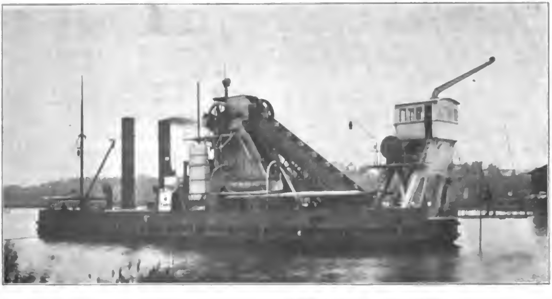


FIG. 1.—GENERAL VIEW OF THE THOR, A BUCKET DREDGE OPERATED ENTIRELY BY ELECTRICITY.

common surface condensing plant. The three dynamos are of the multipolar type, and of a design especially adapted for use on board ship, a special feature being the small space requirements in the direction of the axis, and the ease of coupling to quick-running machines.

The motor operating the tumblers has been designed on similar lines. A switchboard with the necessary switches, fuses and measuring instruments has been provided in the engine room for each of the three dynamos. The connections have been so designed as to allow the winch-operating dynamo to be used also in connection with the lighting plant, and the lighting dynamo for the operation of the winches and cranes. To this effect the lighting and power switchboards are connected together, a double-pole switch on each switchboard enabling, on the one hand, the lighting mains to be connected both to the lighting and power machines, while on the other hand, part of the power circuit can be switched on, both to the power and lighting dynamos.

The hoisting machines and auxiliary machinery serving for the dredging operations proper can be operated only from the power dynamo. A special feeder 310 square millimeters (0.48 square inch) in copper section connects the power switchboard to a switchboard arranged in the pilot house, from the bus bars of which the several circuits for the auxiliary dredging machinery are branched off. The steering apparatus, as well as the reversing shunt controller of the dynamo operating the tumbler, are installed in the pilot house, whence they are controlled. The advantage of electrical power transmission is inferred from the fact that one man is able, without leaving his post, to control all the auxiliary machinery used in dredging.

The dredging buckets have each a capacity of 0.24 cubic meters (8½ cubic feet) on being filled horizontally, with a mean dredging depth of 5.5 meters (18 feet); they have cast-on double joints at the back, which are connected to the simple intermediary joints by means of hardened joint bolts. The bucket chain is guided by rollers located on two framework girders, constituting a bucket ladder of 40 degrees inclination, with an average dredging depth of 5.5 meters. The lowering and lifting of the ladder is effected by means of a 12-horsepower series motor operating with 510 revolutions per minute a winch located on the stern jack. This motor is handled by a reversing controller of the usual design, with short-circuit position and magnetic blowing.

The pentagonal lower tumbler is located at the lower end of the bucket ladder, in which it is free to move. The pentagonal upper tumbler is located on the middle jack, and is operated by a shunt motor of 100-horsepower output with 285 revolutions per minute, through the intermediary of two spur wheel gearings with hydraulic friction clutch. This motor can be regulated between zero and full speed, the arrangement adopted being the Ward-Leonard system. It is provided with separate excitation at 110 volts from the power dynamo, while the tumbler dynamo has a shunt exciter located in the pilot house, and which has been so arranged as to enable the field of the tumbler dynamo to be reversed, in order to impart a backward motion to the bucket chain. The hydraulic friction clutch is intended to reduce to an admissible limit the torque transmitted by the tumbler motor, it being caused to slide whenever the buckets are put to specially heavy strain, due to mechanical resistance in the dredging ground.

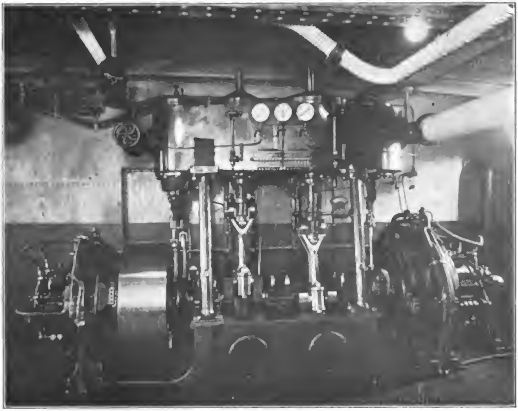


FIG. 2.—COMPOUND ENGINE OPERATING GENERATORS ON THE GERMAN BUCKET DREDGE THOR.

The dredged soil is dropped into a hopper, with chutes connected to both sides of the vessel; at the summit there is a valve for distributing the soil. The chutes are hauled in by series motors of an output of 2 horsepower with 530 revolutions per minute, handled by ordinary reversing starters. The dredged soil can also be poured out through an opening in the stern chute into a tank below deck, whence it is sucked in with

an addition of outside water by one or two centrifugal pumps 1.5 meters (59 inches) in diameter, in order to be carried away a distance of 600 meters (1,970 feet), in a lateral pipe 450 millimeters (18 inches) in clear width, the terminal height being 3 meters (10 feet) above the level of the water. The suction and pressure conduits of the two centrifugal pumps have been so arranged as to enable both pumps to work jointly, or each pump separately.

The dredge is maneuvered on the spot by the aid of a stern winch, two lateral chain winches and a bow winch (anchor winch), while three hauling winches (Fig. 3) have been provided for hauling the steam pontoon. All the winches, as seen from the figure, have been so installed on deck as to leave the latter as clear as possible, while the winches arranged in groups require for their operation the smallest possible number of men. All the motors are operated through worm wheel transmission by slowly running electric motors, which are entirely inclosed to protect them against rain and spray; the tumbler motor is in addition provided with a ventilator. The motor operating the anchor winch is installed below deck in a protected position, and therefore is not of the inclosed type.

The stern winch, the rope drum of which can be thrown out of gear, is operated by a series motor of 14 horsepower and 420 revolutions per minute. The four winches provided for the lateral chains are driven by shunt motors, and the bow winches by a series motor. These five motors are otherwise identical in design, giving an output of 12 horsepower with 510 revolutions per minute.

The controlling apparatus for the stern and bow winches, as well as for those operating the lateral chains, is located in the pilot house, and has been designed as controller rollers, each two corresponding chain winches having a common controller in connection with a switch. The latter enables both motors to be operated simultaneously (when one winch will haul in and the other pay out an identical length of chain), while both motors can be made to operate independently in hauling in or paying out the chain corresponding to one or two winches. In order to insure an entirely uniform winding and unwinding of the chains, while regulating the speed of the latter, a shunt regulator has been provided in the pilot house for each chain winch motor. For the anchor winch, has been installed in its immediate neighborhood another controller roller, enabling the winch if desired to be handled from that part of the ship. Means have, however, been provided for allowing the winch in each case to be started, either from the pilot house or from the winch itself, but never in both ways. The ends of the lateral chains are run either into a pit below water, or over the deck, to be caught below deck in rotary iron boxes.

The three hauling capstans are operated by series motors with watertight oil-cooled starter of an output of 7.6 horsepower with 450 revolutions per minute.

FIG. 3.—STERN OF THE ELECTRICALLY OPERATED GERMAN DREDGE THOR.

Two cranes of a capacity of 3,000 kilograms (6,614 pounds) have been provided for hauling the anchor, removing the chain pit, withdrawing the lower tumbler and dredging buckets, etc. These cranes are driven by series motors of 3 horsepower output with 520 revolutions per minute, the motor of the stern crane being of the inclosed type, and that of the bow crane of the open type. Both motors are handled by controllers arranged close to the cranes. For hauling greater loads on deck, as well as for loading coal, has been installed a loading pole, which at the same time serves as signaling pole.

The electric lighting plant comprises a projector for 30 amperes and parabolic mirror 400 millimeters (15¾ inches) in diameter, four flame-arc lamps for 10 amperes intended for lighting the deck, in addition to about 40 glow lamps of 16 and 25 normal candlepower, in the various compartments. All electric conductors are rubber-insulated bitumenized cables with protective iron bands, which are carried in groups below deck alongside the walls and ceilings, where they are readily accessible.

APPLIANCES FOR MANIPULATING LIFEBOATS ON SEA-GOING VESSELS.*

BY AXEL WELIN.

The last time I had an opportunity of watching regulation boat drill on a large liner the conditions were the most favorable—broad daylight, no wind and the ship in harbor. All the various appliances were evidently kept in splendid order, and each boat's crew as fully acquainted with its duty as circumstances permitted. The ship had, however, a faint list—less than 1 degree—but that alone was sufficient to cause quite apparent difficulty in manipulating the boats.

The sensitiveness in this respect of the usual davit is, therefore, one of the greatest of the many drawbacks incidental to

THE DAVIT ARRANGEMENT ON LA PROVENCE, SHOWING SHEAVES.

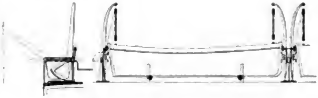
the system. Three to 4 degrees list of the ship instantly reduces its boat capacity by one-half. The Board of Trade regulations, consequently, prescribe in the case of cargo steamers, that the ship shall carry sufficient boats on each side to accommodate the whole crew. That a similar rule does not apply to passenger steamers, where evidently it is so much more called for, is simply the result of the practical impossibility of carrying it into effect.

But the objection which cuts to the very root of the evil is that the system does not and cannot give the crew proper control in handling the boat. The slightest rolling motion of the vessel, when once the guys are loose is apt to throw the boat into a swinging motion highly dangerous alike to itself and the crew. Without prosecuting this criticism further, I will now formulate the principal requirements of an ideal system of davits, such as they present themselves to me after several years of keen and careful study.

1. The boat must in all circumstances, and in every position, be under efficient control.

2. A moderate list of the ship must not prevent or appreciably retard the manipulation of the boat.

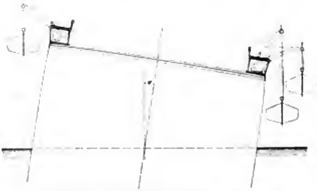
3. The mechanism should be of the simplest possible nature, and always "get-at-able."



THE USUAL TYPE OF WELIN QUADRANT DAVIT OUTFIT.

4. The manner of manipulating the davits must be such as to preclude any necessity for expert training, and all possibility of confusion in cases of accident.

5. Cost, weight and deck space occupied are all matters which must be taken into account, even if they do not come within the scope of the subject, when treated from a strict "life-saving" point of view.

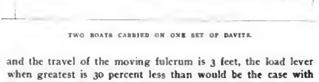


THE USE OF THE DAVITS WITH SHIP HEELED 8 DEGREES.

Reverting to the Welin quadrant davit, I first wish to emphasize one or two purely mechanical points of interest.

THE HORIZONTAL TRAVELING MOTION GIVEN TO THE DAVIT ARM.

The advantages of this arrangement in regard to leverage are apparent at first glance. Say that the distance between the keel lines of the boat in the two extreme positions is 10 feet,



TWO BOATS CARRIED ON ONE SET OF DAVITS.

and the travel of the moving fulcrum is 3 feet, the load lever when greatest is 30 percent less than would be the case with a davit turning on a fixed center, while the working lever (the radius of the quadrant) remains constant throughout the movement, or even increases, as shown in the arrangement for a battleship.

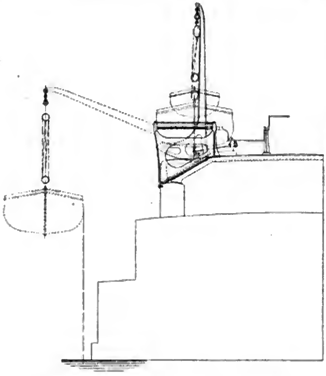
* Read before the Society of Naval Architects and Marine Engineers, New York, Nov. 22, 1907.

THE COMPENSATING ARRANGEMENT OF THE FALLS.

Instead of attaching the falls direct to a belaying pin on the davit proper, they are at first led over stationary sheaves, then belayed on the quadrant. The result is that the pull on the falls tends to raise the davits and, though it sounds like a paradox, part of the weight of the boat itself is thus utilized for lifting it inboard. The explanation is easy.

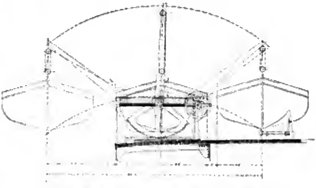
In hoisting the boat from the water it is lifted some distance higher relatively to the upper block than would be necessary if the falls were to be belayed direct on the belaying pin without first being run over the said sheaves, and then, as the davits are swung inboard, the boat drops back. The distance of this drop, multiplied by the weight of the boat, represents the assistance obtained in manipulating the handles, *e. g.*, if the weight of the boat is 30 cwts. and the drop 18 inches, the gain would be 2¼ foot tons, not deducting anything for additional friction and stiffness of ropes.

Generally speaking, the boats are placed at a distance from each other of about 5 feet, which is sufficient for the working of two single davits between the boats. A more compact and perhaps neater looking installation is that formed by double or twin davits between the boats. Some firms, however, object to the use of twin frames on the ground that only half the number of boats in each row can be swung out simultaneously. The objection, admittedly, holds good only in regard to boat drill, when, of course, it is more imposing to see all the boats going out precisely at the same moment. In actual use, the lowering of all the boats simultaneously into the water would, even under favorable circumstances, invite confusion and disaster. When the fitting of single frames is insisted upon, but the length of available deck does not admit of the boats being placed 5 feet apart, a distance piece is dropped over the handles to prevent these from fouling each other, or a special bevel gearing is fitted.



THE WELIN QUADRANT DAVIT APPLIED TO A BATTLESHIP.

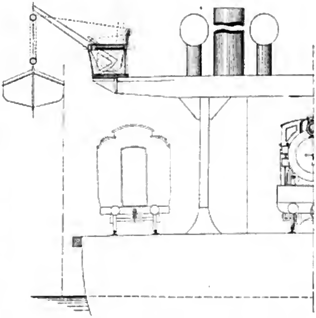
Occasional difficulties have arisen where an excessive outreach has been required. In simple cases where this has been caused merely by the adoption of a particularly wide belting or rubbing strake, it has been surmounted by shifting the center pin of the quadrant relatively farther towards the back of same, and this, coupled with the throwing out of the outboard end of the frame a few inches, has, so far, proved equal to all demands. In the cases of battleships, however, where the boats are so frequently carried on lofty superstructures situated at some distance inboard, the problem has presented more features of interest, especially when the heavy weights of boats, usually carried in vessels of this class, be considered.



THE ARRANGEMENT OF THE DOUBLE DAVIT FOR TWO BOATS.

Increasing the length of the arm is not a practice which can be continued indefinitely, as, apart altogether from the resulting strains and stresses of the metal itself, there is a limit where the excessive labor consequent upon an increased leverage is such that a quadrant davit would offer little or no advantage over the present battleship arrangement for slinging out boats by means of derricks or similar appliances. The plan adopted to gain the end required, while retaining to the full the advantageous arrangement of the quadrant, has been arrived at by what may be termed differential radii being given to the quadrant, with the result that while the boat may be slung out with perfect ease, there is no especial difficulty attaching to bringing it home again, the greatest lever being available when most needed.

Whatever criticism you pass on the Welin quadrant davit as



THE DAVIT AS APPLIED TO A CAR-CARRYING FERRY.

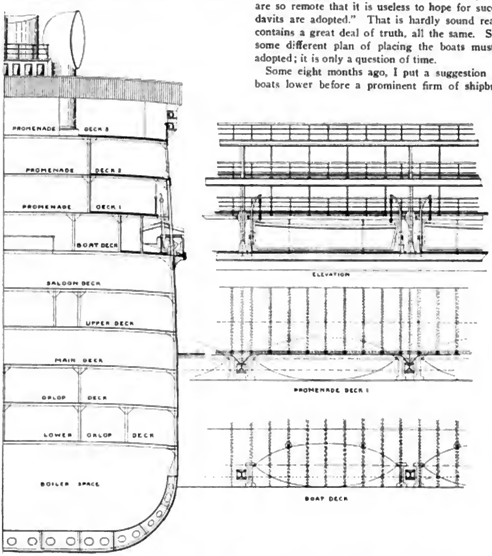
a mechanical contrivance. I am bound to say that its adaptability to all kinds of arrangements of the boats has fairly astonished me. Here are a few examples:

A boat may be chocked half outboard, thereby saving for promenading purposes some 120 square feet of deck space in the case of each individual boat. These are as safe as when stowed inboard, and need only be swung in when the ship enters harbor. To do so requires a fraction of a minute.

The fact that the davit arm always remains in a locked position unless manipulated by means of the screw is one of either side, picked up and swung outboard by the davits. No other gear that I know of lends itself so admirably to a plan of this kind. In a modification of the davit itself, by which a double quadrant is used, a boat standing inboard of another may be picked up direct from its chocks and swung outboard.

Before concluding, I must take up a remark which has been put to me on more than one occasion—"What is the good of taking so much trouble over a question like this? The chances of ever getting any lifeboat safely into the sea from the tremendous height at which they are placed on present day liners are so remote that it is useless to hope for success, whatever davits are adopted." That is hardly sound reasoning, but it contains a great deal of truth, all the same. Sooner or later some different plan of placing the boats must and will be adopted; it is only a question of time.

Some eight months ago, I put a suggestion of placing the boats lower before a prominent firm of shipbuilders on the continent, without at the time obtaining any definite result. I am, of course, fully alive to the many difficulties in the way of getting some such scheme adopted, and it may require a few more of those disasters which stir humanity to its very core before conservatism can be made to budge.



THE BOATS CARRIED ON A LOWER LEVEL THAN USUAL, TO FACILITATE HANDLING FROM A LARGE SHIP.

the more important points about this system. I have included a scale diagram of a ship in section having a list of 8 degrees, wherein you may notice the boats in different positions. In connection herewith I can do no better than quote a few lines out of a testimonial from the North German Lloyd, based upon prolonged trials:

"With a list of 11 degrees of the ship the boat on the high side was put out in forty-five seconds. When the ship was rolling to a fair degree this was again done in one minute by four men, and the superiority of these davits, in so far that they remain stationary at any point without guying, then became apparent."

A row of boats placed abreast on the top of a deck house may be run out one after the other to the edge of the deck on

Shipbuilders do not, as a rule, welcome deviations from orthodox designs; that such deviations, possibly resembling the one fore-shadowed above, must ultimately come, I am nevertheless more than ever confident. At a time when scarcely a month passes without witnessing the birth of some new leviathan, each exceeding its forerunner in speed and passenger-bearing capacity, the compelling necessity for such vessels to be fully equipped with life-saving appliances of the highest order is a fact which cannot fail to thrust itself with an

added force and conviction upon the observation of the most callous.

In bringing these remarks to a close, and speaking, as far as it is possible for me, from an impartial standpoint, I venture to assert that if ever there was a moment when the matter so briefly dealt with in this paper called for careful and renewed consideration, that moment is now, when the gigantic creations of recent months and the rumors of even greater things in the near future, bring to the whole subject a new significance.

construction into two types—metal and wood. The continued growth in dimensions has resulted in almost eliminating the wooden type of construction. In the development of the power element two main factors have controlled, the dimension of the transportation unit and speed at which it was to be driven.

In classifying marine transportation units, the first division that is to be made is between those that are used for passenger transportation, and those that are to be used ex-

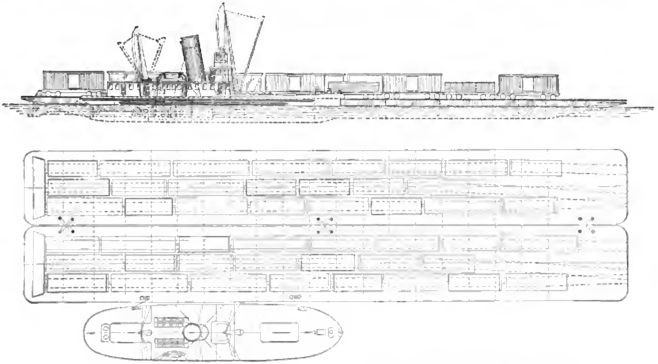


FIG. 5.—MARINE UNIT SYSTEM—POWER BOAT AND CAR FLOATS. ELECTRIC UNIT SYSTEM OF MARINE TRANSPORTATION.
Scale 1/48" = 1 foot.

MODERN MARINE TRANSPORTATION—II.

BY WILLIAM T. DONNELLY.

DETAIL APPLICATION OF THE ELECTRIC UNIT SYSTEM.

In the discussion of marine transportation in its broadest sense, the first division must be made along the line of goods to be transported and the means used in transporting them, and as this paper is to deal mainly with a new application of power to marine transportaion, the discussion will be directed to the means used for transportation. This division embraces the floating structure or vessel to carry the goods, the crew for controlling the same, and the power used to move the vessel and crew from place to place.

That part of the problem represented by the crew involves the provision for their sustenance and living accommodation, and also such recompense for their service as will secure competency in the various branches. The division represented by the vessel involves all the problems of naval architecture, such as form, dimensions and materials of construction. The third division, that of power, involves all the mechanical construction, operation and control of the particular source of power which is to be used, and the fuel from which the power is obtained. It will be necessary to consider each of these divisions under further sub-divisions, as the investigation is carried more and more into detail.

The first result of the application of steam power to marine transportation was to cause a primary division of the crew into a navigating and engineering corps. The development of steel as a structural material resulted in the division of the clusively or primarily for transportation of merchandise. As this paper is to deal in detail with that class of marine units or vessels intended exclusively or primarily for the transportation of merchandise, little consideration will be given to the class in which the propelling power is necessarily so great as to almost exclude the consideration of other factors.

Marine merchandise carriers have again to be divided into classes, each of which is developed for the particular trade to which is to be applied; and the detailed discussion following will first be limited to marine transportation units designed and adapted for use in transporting merchandise in coastwise service for a distance of approximately 100 miles. Comparison will be made between a modern freight steamer of 2,000 tons cargo capacity on the one hand and a fleet of three barges with their power vessel, comprising an electrically operated marine transportation fleet, on the other.

In the movement of freight a very important consideration is the rate of speed at which the movement is to take place. In this system, 10 miles an hour on water has been considered as a speed which would represent ordinary rail freight transportation, including the incidental delays due to yarding and switching, and final transfers upon car floats, which is considered part of the necessary handling of freight in coming and going from the large centers, such as New York, Philadelphia and Boston.

In Table I. are given the details of dimensions and cost in parallel columns of a freight steamer of 2,000 tons cargo capacity, and a combined unit, comprising a power boat and three

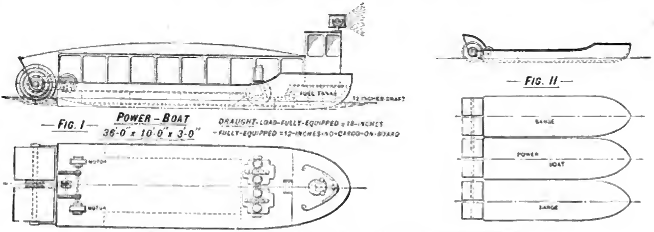


FIG. 6.—ELECTRIC UNIT SYSTEM WITH MINIMUM DRAFT AND MAXIMUM POWER APPLICATION.

TABLE I.

	Freighter	Combined Unit	
		Power Boat	Car Floats
Length	300'-0"	132'-0"	320'-0"
Breadth, molded	38'-0"	30'-0"	40'-0"
Depth, molded	23'-0"	13'-6"	10'-6"
Draft	14'-0"	7'-0"	6'-0"
Capacity in tons: Bunkers	50.	50.	
Capacity in tons: Stores, &c.	20.	5.	
Capacity in tons: Freight	2,000		2,000
Weight of hull	1,150	315	1,200 (a)
Weight of machinery	180	185	40 (a)
Displacement	3,400	555	4,070
Indicated horsepower	1,700	1,400	
Speed, miles per hour	10	10	
I. h.p. per ton freight	0.85	0.7	
Hours operating per month	300	648	
Hours in port " "	420	72	
Mileage " "	3,000	6,480	
Freight capacity " "	60,000	129,600	
Ton-miles " "	6,000,000	12,060,000	
Freight rate per ton-mile	6 mills	6 mills	
Investment: Hull and Machinery	$312,000	$86,000 total, 215,000	$129,000 (b)
Freight capacity per $100 investment	0.641 ton	0.93 ton	
Freight carrying capacity per month per $100 investment	19.24 tons	60.28 tons	
Cost per ton of freight carrying capacity	$156	$107.50	

a Two car floats. b Three car floats.

TABLE II.

Monthly Figures	Freighter	Combined Unit		
		Power Boat	Car Floats	Total
Interest on investment....5%	$1,300	$ 360	$537	$897
Depreciation....3%	780	215	323	538
Pay-roll	1,800	1,025	300	1,325
Stewards' stores	400	280	.....	280
Coal	1,750	3,175	.....	3,175
Engine room stores	150	200	.....	200
Deck stores	50	100	.....	100
Total expenditures	$6,230	$5,355	$1,160	$6,515
Income	$36,000			$77,760
Earnings	29,770			71,245

car floats, each of which will have a net merchandise carrying capacity of 2,000 tons.

It will be seen from this table that the dimensions of the steamer will be—length 300 feet, breadth 38 feet, and draft 14 feet, and in the comparison, the first noticeable feature is the reduction of draft, it being entirely practical to reduce the draft of the power boat to 7 feet, and that of the car floats will be only 6 feet. It is at once apparent that this will extend the possible navigation over a much larger territory. It will be seen that the indicated horsepower for the fleet is slightly less than for the single vessel, this being occasioned by the much easier form of the car floats over the freight steamer of the dimensions given.

It is assumed that the freight boat will make one trip a day, or will operate 300 hours per month, while two of the car floats and the power boat will be in operation 90 percent of the time, or 648 hours per month. Under this schedule the steamer will make 3,000 miles per month, and the combined unit 6,480 miles, giving a monthly capacity for freight of 60,000 tons for the steamer, and 129,600 tons for the combined unit.

The freight rate is taken as 6 mills (1.2 farthings) per ton-mile. This is not an arbitrary rate, but one determined from the average of a number of years in the coastwise trade.

From carefully prepared figures the total investment for the hull and machinery of the freight steamer is placed at $312,000 (£64,112); that for the power boat at $86,000 (£17,672), and for three car floats, $129,000 (£26,508), or a total for the unit of $215,000 (£44,180).

It will be seen from the figures that for each $100 investment in the freight steamer, provision is made for carrying 0.641 ton of freight. In the combined unit, considering only two car floats to be in use at one time, for the same investment of $100, 0.93 ton is carried. The comparison of freight carrying capacity per month on an investment of $100 is 19.24 tons for the freight vessel, and 60.28 tons for the combined unit, or more than three times as much. Comparing the investment per ton of freight carrying capacity, that for the steamer is $156 (£32), and for the combined unit $107.50 (£22).

Referring to Table II., there will be seen a comparison of the operating expenses and revenue to be derived. The interest on the investment is taken as 5 percent in both cases, and the depreciation at 3 percent. The pay roll in each case has been made up by careful comparison and investigation of operating expenses on the Atlantic coast of the United States. The consumption of coal has been taken at 2 pounds per horsepower-hour, and at a cost of $3.50 (14/4½) per ton, the same in both cases.

It will be seen that the total expenditures monthly for the freight steamer will be $6,230 (£1,280), and for the combined unit, $6,515 (£1,339).

The income at 6 mills per ton-mile for six million ton-miles per month will amount to $36,000 (£7,398) for the freight steamer, and for the combined unit, with 12,960,000 ton-miles per month at the same price, will amount to $77,760 (£15,979), leaving a net monthly earning capacity, for the steamer, of $29,770 (£6,118), and for the combined unit, $71,245 (£14,640). From the monthly earnings, as stated, there would, of course, have to be deducted the ordinary and extraordinary repairs. While these items have been omitted to simplify comparison, it is confidently believed that they would be much less in the transportation unit than in the freight steamer.

Attention is called to the fact that an extra car float is provided, which would make it possible to repair the freight carriers without interfering with the business, while in the case of the steamer, any repair which would interfere with operation would at once eliminate all earning capacity.

It may be contended that this service is properly a tug-boat service; but it is submitted that in the bays and sounds of the coast, and near the mouths of large rivers, a great quantity of this class of transportation is carried on by steamers, further contended that great saving would result in wear and tear of heavily loaded cars, both to the cars themselves and to the railway's roadbed, by shipping all heavy machinery by car float lines.

It should further be pointed out that at the present time a very large percentage of the freight arriving at large centers of shipment, such as New York, Philadelphia, Boston and Baltimore, has necessarily to be run upon car floats for distribution, and often to load to and from cars alongside of steamers, and if it is a fact, as has been shown, that the cars upon the float can be moved at a rate of 10 miles per hour, at a cost very much less than upon railroads, it should be apparent that this branch of transportation will have a very great extension, if the power necessary to move the freight can be applied on as small a draft as 7 feet. This extension would make it possible for any and all railroads to have shipping facilities at great seaports for such commodities as can be handled direct between cars and vessels.

MECHANICAL AND ELECTRICAL EQUIPMENT OF TRANSPORTATION UNIT.

Referring to Fig. 4, which illustrates the power boat: This boat is designed to have a length over all of 132 feet, a breadth of 30 feet, a depth of 13 feet 6 inches, and a draft of 7 feet.

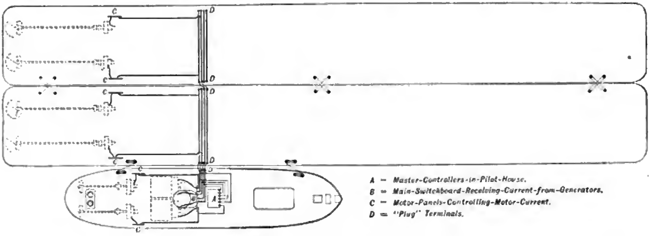


FIG. 7.—WIRING LAYOUT FOR POWER BOAT AND CAR FLOATS.

under the conditions set forth, and that it is a well recognized fact that for a tug to handle two car floats of the dimensions given it would require to have a draft of not less than 14 feet, and even then it would be impossible for the tug to control the car floats in moderately heavy weather.

One of the greatest advantages of this system over the use of a tug lies in the greater facility in docking the floats; nearly all the float bridges are so located that a strong tide sweeps by, and great difficulty is experienced in properly making the slips. With this system the power boat, with its bow against the car float, would act as a tug to hold it against the swing of the tide, while the electrical power applied to the propellers of the float itself would move it across the tide into the slip.

Too much consideration cannot be given to the reduction of draft which is possible in the power boat over the tug. This would mean a great extension of the car float business, and enough has been said to make it clear that there is no other system by which freight can be handled for so little cost. It may be contended that it would not be possible to always have the freight cars loaded to their full capacity, for much light and bulky freight has to be carried. On the other hand, it is submitted that the freight rate for light and bulky articles is increased to the point where the revenue per car is practically the same amount. And it is

The boiler equipment comprises two Scotch marine boilers, each 12 feet in diameter by 11 feet 6 inches long, each to contain two Morison furnaces, and containing a total heating surface of 1,736 square feet, and a grate area of 48 square feet (36.2 to 1). The boilers are designed for 175 pounds working pressure, and will furnish steam to two vertical compound condensing, self-contained, inclosed Williams engines, with cylinders 15 and 26 inches in diameter by 21 inches stroke, operating at a normal speed of 220 revolutions per minute. This engine is guaranteed to develop a horsepower-hour on not to exceed 14 pounds of steam. The total weight of these engines, with extended base, shaft and flywheel complete, without generator, will be 74,000 pounds each.

Electric Generators.—These will consist of 500-kilowatt, compound-wound generators, over-compounded to maintain a constant voltage at the motors. The main switchboard will be installed, equipped with two main dynamo switches, six power feeder switches, and the usual circuit breakers, voltmeters, ammeters, ground detectors, etc. It is planned to use circuit-breakers in place of fuses on the motor circuits, as these can be automatically reset by moving the master controller to "stop" position. Auxiliary circuits will be provided for lighting, hoist motors and similar minor duties.

Electrical Transmission.—Each propeller will be driven by

a 200-horsepower, 500-volt compound-wound, variable speed, reversing, direct-current motor of interpole type, with wide range of field control.

Wiring Connections.—The wiring connections for the motors will be carried to controlling panels located close to the motors, and equipped with the latest electrical controlling devices automatically operated from a distance. This arrangement provides a minimum number of heavy conductors carried to the power boat. The system of wiring on the floats and power boat is shown in diagram on Fig. 7.

As the connections between the different vessels will be made by flexible multiple cables, the connections are indicated by single lines on the diagram. The connecting cables will be made long enough so that they may have sufficient slack to allow for such relative movement of the vessels as will be occasioned by rough water. Lashing of the vessels together by hawsers will prevent any mechanical strain coming on the electrical cables.

The use of multiple cables makes light the manual labor of connecting, so that the plugging in of a single cable is the only operation necessary for connecting any one motor. On account of the light strain between vessels with this system of propulsion, the lashing hawsers need not be so heavy as now used, so that this part of the work will be lighter, and will offset the time required to make the electrical connections.

Power Boat Switchboard.—On the power boat the main conductors will lead to the switchboard in the engine room, and the controlling wires will be carried to the pilot house, where they will be connected to master controllers of similar appearance to the familiar engine room telegraph. By moving the different levers the pilot will be enabled to run any motor in the fleet, in any direction and at any speed. Nor will there be any delay in the execution of his orders; the electric controllers at the motors will "stand by" with unceasing alertness, and will never be caught napping.

Marine Freight Carriers.—As a freight carrier for protected and inland waterways, probably no form is more highly developed than the car float. One of these floats of the dimensions given, i. e., 320 feet in length, 40 feet beam, 10 feet 6 inches deep, and 6 feet draft, will carry twenty-three freight cars, representing a total net freight-carrying capacity of 1,000 tons. When it is considered that this amount of freight can be removed at a car float bridge by a locomotive in ten minutes, and the float reloaded with another 1,000 tons within another ten minutes, a very great economy in handling is apparent. It is desired to call attention to the fact that a transshipping terminal for this kind of freight requires but a minimum draft, no wharves or warehouses, as the goods are always protected from the weather in cars, and is very inexpensive to build and maintain.

The structure of the hull of the car float is of the simplest form, and as the hold is not used for any purpose, no complication results from dividing it into various watertight compartments, rendering loss from collision highly improbable. It should also be pointed out that the draft of a car float does not increase with the size of the float or the number of cars carried, but remains practically constant, admitting of very great extensions to shallow-water navigation. Altogether, it would appear that the addition of propelling power to the present steel car float is all that is necessary to very greatly extend its use in the field of marine transportation.

The most remarkable part of this system is that all the apparatus, from the boilers to the electric controlling apparatus operated from the pilot house, is of standard make, and can be procured in the open market. No special apparatus of any kind is required. The cost of all mechanical equipment has been arrived at from actual figures supplied by the manufacturers of the apparatus.

The total cost of the power boat is $86,000 (£17,672), which represents about $61.50 (£12-12-6) per horsepower, on a basis of 1,400 horsepower. A central station plant on land for generating electrical power can be constructed and equipped, where the cost of real estate is not high, for $65 (£13-7-2) per horsepower. From this it is apparent that a floating station for generation of power will be on approximately the same basis of investment as a central station on land; but with the very great advantage of a trifling cost for distribution and connections, and little or no distribution losses, and the additional very great advantage that it will work at full load capacity, which is the condition of highest economy.

The cost of fuel for a floating power station will be, if anything, less than for a central station located upon the water front, as it is apparent that the floating power station can go to the large centers of fuel supply and receive its fuel with the least amount of handling.

Finally, it is desired to point out that in all transportation the vital consideration is the application of power, and that the value of all investments in railroads, cars, locomotives, steamships and other means of transportation depends solely upon the effect produced by the application of power. The second principle involved is, that the amount of revenue for any particular investment in equipment is entirely dependent upon the constant effective application of power to the means used for transportation. And third, that the amount of transportation which can be accomplished with any particular equipment is largely dependent upon the amount of power that can be economically applied to its movement.

While in the foregoing analysis and illustration modern marine boilers and vertical reciprocating engines have been used in the power producing plant, it is apparent that this particular source of power is not an essential. Turbine engines may be used, or the steam plant may be replaced by the gas producer and gas engine, or any form of internal combustion engine with oil as a fuel.

Electrically Equipped Shipbuilding Berths.

There has been installed at Palmer's yard, Jarrow, a system of overhead cableways upon which electrically operated trolleys run. These cableways are supported by carriages held by braced supports, 125 feet above the berth, which allows them to be traversed across the berth while the trolley itself runs longitudinally. All the motions of longitudinal and lateral hoisting in handling materials are accomplished by means of electric motors. The cable span is 490 feet.

John Brown & Company's yard at Clydebank is equipped with vertical derricks, 100 feet apart, capable of lifting a load of 5 tons to a height of 125 feet from the ground. The mast is a braced column with a length of 130 feet. It is square in section, having a side of 6 feet at the center and tapering toward the ends. The jibs are also of square section. Hoisting is accomplished by an electric motor of 35 horsepower, while the jib is slewed by a motor of 10 horsepower.

The Dalmuir dock of Beardmore & Son is supplied with overhead traveling cranes run on a large gantry, the two sides of which are braced together, and may be roofed over for protection from the weather. The side braces are also provided with side walking cranes which travel along them, working from any point. These are capable of handling loads of 5 tons at a radius of 30 feet. The traveling cranes have a span of 108 feet, a total travel of 750 feet along the berth, and are capable of lifting 15 tons to a height of 140 feet. Power for all of these operations is supplied by means of electric motors. In the storage yard of the same plant is a long electric cantilever crane for handling plates. This is carried on a gantry, and has a total travel of 240 feet and a clear lift of 22 feet above the rail.

THE HEATING AND VENTILATING OF SHIPS.

BY SYDNEY F. WALKER, M. I. E. E.

METHODS OF HEATING AVAILABLE.

The following methods of heating, which are in use on shore, are all available more or less for use on board ship, some of them, as will be explained, being more easily adapted under all conditions, and some of them again not being suitable for ships that knock about in a sea way, but being quite practicable for those which keep an even keel:

1. The open fireplace, or closed stove burning coal.
2. Pipes or apparatus in which hot water is circulated.
3. Pipes and apparatus into which steam is delivered.
4. Apparatus in which electric currents are employed.
5. Apparatus in which the air is warmed, humidified, and, if necessary, cooled.

The last form of apparatus, it will be noted, combines heating and ventilating, and on shore that is the latest development. Many of the large new buildings, such as hospitals, government and municipal buildings, stock exchanges, etc., are warmed and cooled, where necessary, entirely by means of the air current, which is taken hold of, cleaned, dried where necessary, warmed where necessary, moistened where necessary, and so on. The latest development of heating and ventilating on board ship, on the great ocean liners and in men-of-war, is on these lines.

The old fireplace and stove, though it still holds a large place in the warming of rooms on shore, has long been condemned as inefficient, because the larger portion of the heat liberated by the combustion of the coal passes up the chimney. It is not necessary to remind marine engineers that a coal fire will burn only with a draft, and that the products of combustion are carried up the chimney, necessary with all coal fires, and with it the larger portion of the heat liberated. A certain quantity of heat passes out into the room from the glowing fire, by radiation, but it does not heat the air of the room, because the air is almost transparent to heat rays. The rays of the sun pass through our atmosphere without heating it to anything like the extent to which they heat any object against which they impinge, and the same thing holds with heat rays from a fire. Rooms, cabins, saloons, etc., however, in which either open fire places or closed stoves are used, are appreciably heated after the fire has been burning for some time, unless they are subjected to cold air drafts, or unless the walls of the cabin, etc., are also the unprotected sides of the ship, and the heat is thus conducted away; because the heat rays emanating from the glowing fuel and striking upon the furniture of the room, the bulkheads, etc., heat them up, and they in turn heat the air with which they are in contact, convection currents being set up in the well known manner, and the whole room being thoroughly warmed.

Where closed stoves are employed, and particularly where a certain length of iron chimney connected with the stove is within the room to be warmed, the heating effect produced is considerably greater than with an open fireplace, because of the radiation from the stove itself, and from the pipe.

A somewhat interesting method of heating a cabin, which the writer remembers to have seen in his younger days, may be worth mentioning. In an old wooden frigate of the British Navy, in which he served, the commander had his cabin heated in cold climates, as when going around Cape Horn, by an 8-inch spherical shot, heated to redness and suspended from the deck above by an iron rod, screwed into the plug hole of the shot. The ship was armed partly with old 8-inch smooth bore guns firing spherical shot, and as these always had a plug, it was an easy matter for the armorer to screw into it an iron rod having a hook at the other end, for suspending from overhead. The result was very good. The commander's cabin was a fairly large one, and it was well warmed, but the process of heating was rather troublesome. The shot had to be heated in the galley fire.

For many ships, tramps for instance, sailing ships, and the numerous coasting vessels, barges, and so on, the coal stove with its chimney passing up through the deck will probably long remain the only method of heating, though some of the apparatus to be described later would be found very suitable for tramps, whalers, sealers, etc., and even for the five-masted sailing ships that are still in being.

THE SYSTEM OF HEATING BY HOT WATER.

This is the favorite system on shore, but so far it has not found much favor on board ship, because of the difficulty

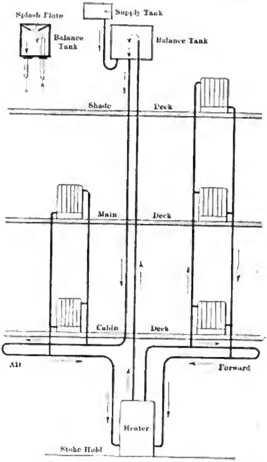


FIG. 3.—HOT-WATER HEATING SYSTEM APPLIED TO A YACHT. RADIATORS CONNECTED BETWEEN MAIN RISER AND RETURN; ALSO BETWEEN PIPE FROM BALANCE TANK AND THE RETURN.

mentioned above, introduced by the motion of the ship, straining different parts of the apparatus, and causing currents in the water with increased chances of air lock. Heating by hot water is a very simple matter. In its simplest form there is a boiler specially designed for heating water to a temperature of about 180 degrees F., and a system of pipes connected to the boiler in such a manner that the water is kept continually circulating from the hotter portion of the boiler through the pipes, and the radiators, as they are called, back to the boiler. An addition, however, is usually made to the system in the shape of a storage tank. Fig. 3 gives a diagram of the usual arrangement of hot-water heating systems, as applied on shore, and as it has been applied in certain cases on board ship. The diagram shown is taken from a hot-water system fitted on board a steam yacht.

The special boiler employed for heating the water may be displaced by steam from the boiler supplying the ship's engines, or from a special boiler arranged for the purpose, or the exhaust steam from the auxiliary engines may be used. Both of these plans are adopted on shore, the heat from the steam being delivered to the hot-water service by an apparatus which goes by the barbarous name of "calorifier," one form of which is shown in Fig. 4. This will be recognized by marine engineers as a feed-water heater. There is the usual cylinder, which may be fixed vertically or horizontally, with pipes inside in which the water to be heated circulates, steam passing all around them in the remaining space inside the cylinder. Or the reverse arrangement may rule, the steam may pass through pipes inside the cylinder, and the water occupy the space surrounding.

The calorifier has been arranged, in certain cases, with automatic steam control. Fig. 4 shows Royle's automatic steam control. A rod of steel is stretched between the top plate of the apparatus and the casting forming the bedplate, and is

FIG. 4.—ROYLE CALORIFIER WITH AUTOMATIC CONTROL.

provided with a pair of nuts, enabling it to be tightened or loosened. A valve controlling the steam supply is fixed about the middle of the rod, as shown, the opening of the valve being controlled by a spring on the one hand, and the rod on the other. The expansion and contraction of the body of the apparatus, with the heat delivered to it, opens or closes the steam valve, by pushing against the head of the valve, or releasing it, thus increasing or decreasing the supply of steam. Another form of control consists of a bent tube, inclosed in a box, operating the steam valve in very much the same manner.

On shore, hot-water heating appliances are often combined with hot-water supply. This arrangement is very common in private houses, and also in hospitals, infirmaries, etc. When this arrangement rules in large establishments, it is usual to have a hot-water storage tank, in addition to the calorifier. The arrangement is as follows: Steam from the boiler supplies heat to the calorifier, the condensed steam being carried back to the hot well. The water pipes from the calorifier are connected to the storage tank, and the water is kept continually circulating through the storage tank, and through the calorifier. The supply of hot water for the establishment is taken from the storage tank. When very little water is used, the temperature of the water in the storage tank increases, and the controlling apparatus of the calorifier reduces the supply of steam, or completely shuts it off, until water is used again. When water is used, cold water, as will be explained, taking its place and the temperature in the storage tank being reduced, the temperature of the calorifier is also reduced and the steam is readmitted and so on.

High and Low-Pressure Hot-Water Heating.—There are two methods of heating by hot water, known, respectively, as high and low pressure. The main difference between the two is in the temperature to which the water is raised, and the velocity at which it circulates. In the high-pressure hot-water system, small pipes, usually of ⅞-inch bore, carry a small quantity of water at a high temperature and a high velocity, while in the low-pressure system larger pipes, from 1 to 6 inches bore, carry a larger quantity of water at a lower temperature and at a lower velocity. There is a further difference between the two systems also, in that the high-pressure system is hermetically sealed, an air vessel being provided to take up the expansion of the water mentioned below. In the low-pressure system a balance tank is usually provided, as shown in Fig. 3, which performs the double office of taking up the expansion of the water and supplying any waste that may take place.

DIFFICULTIES IN CONNECTION WITH HEATING BY WATER.

There are two principal difficulties to be encountered in heating by hot water, the expansion of the water itself, and the presence of air in the system. Water expands approximately 1/23 of its bulk between its point of greatest density (39 degrees F.) and its boiling point at standard barometric pressures. The following are the actual figures:

Temperature of the Water.	Relative Volume.
39° F.	1.
100° F.	1.0075
200° F.	1.038
212° F.	1.043
300° F.	1.086
400° F.	1.148
500° F.	1.223
600° F.	1.310

The expansion of the water must be provided for, and in the high-pressure system this is done by the expansion pipe, mentioned above, fixed at the highest point of the system and connected to it. The arrangement is merely a pipe calculated to accommodate a certain quantity of air, in proportion to the quantity of water in the system, and to the temperature of the water. The proportions recommended by Walter Jones, a past president of the Institution of Heating and Ventilating Engineers of Great Britain, are as follows:

With water at a temperature of 212 degrees F., the expansion pipe should have an air space equal to 1/20 of the water space in the whole apparatus. At 300 degrees F., the air space should be one-eighth of the water space. At 400 degrees, one-fifth; at 500 degrees, one-third, and at 600 degrees, one-half.

The operation of the expansion pipe is really that of a buffer. As the water expands it is forced upwards, and the air in the expansion pipe is compressed. If the expansion pipe and the whole of the system is sufficiently strong to withstand the pressure, and if the quantity of air in the expansion pipe is sufficient, when the water cools, the air expands, and equilibrium is maintained in the system and it works safely. The great danger of the high-pressure system is the possibility of explosion, owing to the very high pressures that are sometimes present. The expansion pipe, it will be seen, acts very much as a safety valve, in addition to its operation as a buffer.

With the low-pressure system there is no danger of explosion, except in case of frost in any part of the system, a

matter that will be dealt with below; because, as seen in Fig. 3, the expansion of the water is fully provided for by the balance tank. The increased volume of the water produced by the increased temperature merely flows into the balance tank harmlessly, and when the system cools, the balance tank resupplies the water required to fill the pipes. The balance tank or auxiliary tank is usually connected to the water-supply service, to that any shortage of water in the system caused by leakage or evaporation is made up automatically. The balance tank should be fixed above the highest part of the pipe and radiator system.

THE AIR TROUBLE.

The air trouble is often a very serious one in both high and low-pressure hot-water systems, and it is the trouble that is likely to arise in connection with hot-water systems on board ship, and that is one reason, the writer believes, why hot-water heating has not been adopted. As marine engineers know, air is always present in water. It is lighter than water, and always finds its way to the highest part of the hot-water system, and if allowed to do so will come away harmlessly. On the other hand, if there are bends, particularly in the forms of inverted

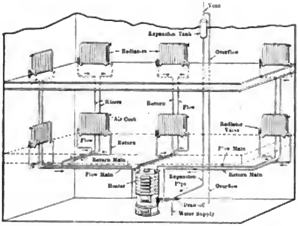


FIG. 5.—TWO-PIPE SYSTEM, LOW PRESSURE HOT WATER.

U's, dips, etc., in the pipe system, air is sometimes trapped, and becoming compressed by the expansion and flow of the water, sometimes operates against the flow to such an extent as to even stop it altogether.

Engineers are all familiar with the troubles that arise with air when water is being pumped. In particular, the old trouble of the air lock in the bend of a siphon is well known; air, if allowed to collect in the bend, becoming gradually compressed and interrupting the flow of water. Something similar to this is of somewhat too frequent occurrence with hot-water systems, and it will easily be understood that when a ship is knocking about, and when currents are produced in the water circulation, quite independent of its circulation proper, and when possibly air may leak into the system through joints being strained, air locks may occur in certain parts of the system, with the result that the circulation of the water is interrupted, heating at the radiators ceases and dangerous heating may take place at the boiler or calorifier. The air locks are easily guarded against by the provision of air valves, which allow the air to escape under the conditions that have been named. It is usual on shore to place either small air pipes, or air valves, at the top of the system, and also at the tops of all bends, etc., and at each radiator, so that any air that is trapped may come away harmlessly.

THE ARRANGEMENT OF HOT-WATER HEATING SYSTEMS.

There are, broadly, two methods of arranging hot-water heating systems, both on the high-pressure and low-pressure working. It is necessary, as will easily be understood, for the water that is delivering heat to the rooms to be warmed, in order to make a complete circuit. Setting out from the hottest part of the boiler or calorifier it ascends through what is usually known as the riser or flow pipe, to the highest part of the system, and is connected to the balance tank above that, or to the expansion pipe, as explained. Another pipe rises from the coolest part of the boiler or calorifier to the same level as the riser, or a little below it. This is the return pipe, and in one method of distribution the heating appliances are connected between these two, very much as electric lamps are connected between the two supply cables, and as shown in Fig. 5.

The heated water passes from the boiler through the riser, through the different heating appliances, and returns to the boiler by the return pipe, becomes again heated in the boiler or calorifier, and repeats its journey. Where there are two or three floors or decks to be heated from the same apparatus, the different heating appliances are connected to the riser or flow pipe and to the return pipe of each floor or deck. One heating appliance may be connected between the flow and return, or two or more, according to the difference in temperature between the two, and to the sizes of the heating appliances and the quantity of heat required for them. Where a single heat-

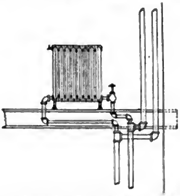


FIG. 6.—CONNECTIONS OF RADIATOR TO A HOT-WATER SYSTEM WITH TWO-PIPE DISTRIBUTION.

ing appliance is connected between the flow and return it would correspond with the usual arrangement of incandescent electric lamps connected in parallel. Where two or more heating appliances are connected between the flow and return, in such a manner that the water flows through them consecutively, the arrangement would correspond to the parallel series arrangement of incandescent electric lamps.

There is a third arrangement, corresponding roughly to the series system adopted in electricity, as with a number of arc lamps employed in street lighting, from a Brush arc machine. In this system the flow pipe is taken to the highest part of the service, say to the highest deck, or a little above, if possible, in the funnel casing, and is there connected to the balance tank or the expansion pipe in the usual way; but the two connections to the heating appliance are made to two portions of the return main pipe, as shown, the heating appliance being bridged across that portion of the pipe. This corresponds to the method known in electrical work as shunting.

Fig. 7 is a diagram of a number of radiators fed on the one-pipe system, the radiators being bridged across a certain length of pipe, but, as will be noticed, two radiators are fed from one bridge, and in this case the connection to the balance tank is separate. Fig. 6 shows the connections between a single radiator and the two pipes on this system. Fig. 8 is a diagram of a system in which the exhaust from a gas engine is used to heat the water, which is carried to a tank above the highest radiator, connection being made from the hot-water tank to the balance tank above; and the distributing pipes

commencing from the hot-water tank and returning to the water-jacket of the engine, and thence to the heating apparatus, the radiators being bridged singly across short lengths of the pipe. Practically, with this method, the heating appliance is fed by a shunt current from the return supply main of the service.

It will be understood that what is required for the supply of any heating appliance is a sufficient difference of tempera-

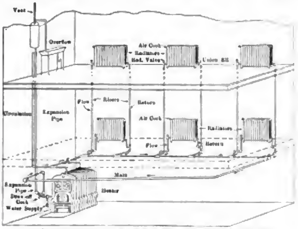


FIG. 7.—DISTRIBUTION OF LOW-PRESSURE HOT WATER ON THE ONE-PIPE SYSTEM.

ture between the inlet and outlet valves, and a sufficient supply of water to keep up a continual flow through it, and of such a temperature that the requisite quantity of heat will be given off by it. In practical hot-water heating, the difference of temperature between the two ends of any radiator is usually not more than 10 degrees F., and it is evident that this can be obtained either by having a very small difference of temperature between the main flow pipe and the return flow pipe, but with comparatively large pipes, bridging the heating ap-

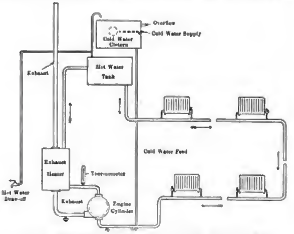


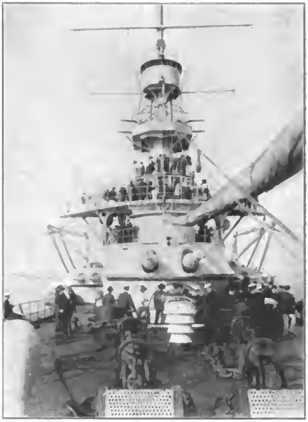
FIG. 8.—DIAGRAM OF A HOT-WATER SYSTEM DRAWING HEAT FROM THE EXHAUST OF A GAS ENGINE. (BRITISH INSTITUTION OF HEATING AND VENTILATING ENGINEERS.)

pliance between the two pipes, as explained; or by having a larger difference of temperature between the ends of the flow pipe and return pipe at the source of heat, with smaller pipes, and a smaller quantity of water flowing, but with a larger difference of temperature in any given length of pipe.

To take an instance, supposing that ten radiators are to be supplied from a given source of heat, and that each radiator requires a difference of temperature between its inlet and outlet valves of 10 degrees, as explained, and a flow of ten gallons of water through it per hour. Evidently this can be supplied by a system of large pipes, giving 100 gallons per hour, but with a difference of temperature between the main flow and return pipes of only 11 or 12 degrees F. at the source, or it can be supplied by pipes carrying only 10 gallons per hour, but with a difference of temperature between the main flow and return pipes, at the source of heat, of 110 to 120 degrees F. Practical men on shore incline very much to the latter system, because it enables smaller pipes to be employed, and they caution engineers to avoid the former system, because the water tends to become "short circuited"; that is to say, the nearer radiators receive the major portion of the heat. Evidently the matter is only one of proper arrangement.

It should be perfectly practicable, by a proper system of pipes, to arrange that the difference of temperature between the main flow and return at the top of the system shall be very nearly the same as that between them at the lower portions of the system. What is required, of course, is proper proportion in the size of the main and return pipes, and proper proportion in the pipes connecting them to the radiators. If the main flow and return pipes are small, and if again the radiators on the lower decks are connected to them by comparatively large pipes, they will undoubtedly short circuit the system.

(To be Continued.)



THE FORWARD TURRETS OF THE ARMORED CRUISER VICTOR HUGO.

Trials of Armored Cruiser Victor Hugo.

This cruiser, which recently paid a visit to New York harbor, underwent her official trials early in the summer. She is a sister of the *Léon Gambetta*, illustrated and described at some length in our issue for April, 1906, the *Jules Ferry*, the trial trip of which was noted in our September, 1906, number, and the *Jules Michelet*. Each of these vessels has a length between perpendiculars of 486 feet 9 inches, an extreme beam of 70 feet 3 inches, a mean draft of 26 feet 7 inches, and a

THE FRENCH ARMORED CRUISER VICTOR HUGO.

displacement of 12,606 tons. The draft fully loaded is 27 feet 11 inches, under which condition the bunkers contain 2,200 tons of coal and liquid fuel. The normal coal supply is 1,400 tons.

The battery consists of four 7.6-inch guns, mounted in pairs in turrets forward and aft; twelve 6.4-inch guns, likewise in pairs in turrets, and four more of this size in casemates. In addition, there are twenty-two 3-pounders and two 18-inch torpedo tubes. The turret armor for the heavier guns has a maximum thickness of 8 inches, and 5½ inches for the 6.4-inch guns. The casemates have armor 4.72 inches, with top and bottom plates 1 and 1.2 inches, respectively.

There are twenty-eight Belleville boilers, discharging their products of combustion into four funnels 69 feet high. The boilers are distributed in eight boiler rooms, and contain a total of 1,660 square feet of grate and 55,830 square feet of heating surface, the ratio being 33.6 to 1. The three screws are actuated each by a four-cylinder triple-expansion engine with pistons 39, 59, 65 and 65 inches in diameter, and a stroke of 37 inches, the revolutions being 125 per minute.

The full speed three-hour trial with all boilers at work gave 28,426 horsepower and 22.55 knots as an average, the maximum being 29,048 horsepower and 23.12 knots. This compares with 27,500 horsepower and 22 knots in the contract, and with 29,008 horsepower and 23.06 knots in the trial trip of the *Léon Gambetta*.

The 24-hour coal consumption trial at 16,000 horsepower called for a consumption per horsepower-hour of not more than 1.875 pounds of coal. The actual consumption with 16,911

DECK OF THE ARMORED CRUISER VICTOR HUGO: VIEW LOOKING AFT FROM THE NAVIGATING BRIDGE.

horsepower and a speed of 19 knots was only 1.45 pounds. This compares with 1.68 pounds in the *Gambetta* at a speed of 20.37 knots.

The low-power consumption trial of 6 hours with four boilers only at work showed 2,500 horsepower with a speed of 10.3 knots. The consumption here per horsepower-hour was 1.435 pounds, as compared with 1.875 permitted under contract.

J. PELTIER.

SOME EXPERIMENTS ON THE EFFECT OF LONGITUDINAL DISTRIBUTION OF DISPLACEMENT UPON RESISTANCE.*

BY PROFESSOR HERBERT C. SADLER.

During the past year a partial investigation on the subject of this paper has been conducted in the experimental tank of the University of Michigan; and although the results hereby submitted apply only to one type of vessel of a given ratio of beam to length, they may prove of interest and value. Further experiments are being conducted upon models of finer and fuller types, the results of which will be submitted at a later date. All the models were run at three different drafts and on an even keel. The three drafts represent about the limits at which the particular form would be run in general service, *i. e.*, from the ballast to the loaded condition.

TABLE OF PARTICULARS.

$\frac{L}{B}$	$\frac{B}{D}$	$\frac{L}{D}$	COEFFICIENTS.		
			Block.	Prism.	Midship
8	3.0	24	.697	.734	.949
8	2.5	20	.715	.747	.956
8	2.143	17.143	.733	.760	.964

The object of the investigation was to determine the effect of distribution of displacement only. With this end in view, the length, breadth, drafts, coefficients of form and hence displacement, were kept constant throughout the series. A set of lines representing one of the existing transatlantic intermediate type was taken as a basis or mean form, and the longitudinal distribution of displacement varied as shown in Fig. 1. In general the two extreme forms represent: First, a vessel with 40 percent parallel middle body, and hence rather fine ends; and, second, a vessel with no middle body and rather fuller ends, the midship section being the same for all types. The form with the fine bow and stern is marked 1, or rather 1B, 1S, and the full bow and stern 3, or 3B, 3S, the middle form being marked 2.

The curves of sectional areas are plotted as percentage curves in all cases with the area of the midship section as 100. The body plans of the two extreme types are shown in Fig. 2. It may be remarked that none of the forms is particularly extreme or beyond the pale of practicability.

In order to eliminate as far as possible any variation in general shape of section at the ends, the ordinates of each section were proportioned from the type vessel. For example, the area of section 2 for form 3 from the curve of sectional areas is approximately 1.10 times that of the same section for form 2. The ordinates of section 2, form 2, were therefore increased by this amount, and similarly for the other sections.

In all, five different models were made as follows: 1 bow, 1 stern (1B, 1S); 1 bow, 3 stern (1B, 3S); 2 bow, 2 stern (2B, 2S); 3 bow, 1 stern (3B, 1S), 3 bow, 3 stern (3B, 3S). The combination of fine and full ends gives some idea of the relative importance of the bow and stern in each case.

All models were run at speeds ranging from a speed-length ratio $V/\sqrt{L}$ of about 0.2 up to 0.8, and in the case of the lighter draft, 0.9 or over; it may be remarked, however, that vessels of this particular form would hardly be run at a higher speed-length ratio than 0.75 in actual practice, and certainly not lower than 0.60. The results of the experiments for the medium draft are shown in Fig. 3. The surface friction has been deducted and the curves represent the residuary resistance only, or rather the ratio of residuary resistance to displacement, in pounds per ton (2,240 pounds). They are plotted on a speed-length ratio base, *i. e.*, the abscissæ represents $\frac{V}{\sqrt{L}}$ where V is the speed in knots and L is the length in feet. The results are therefore independent of absolute dimensions.

An examination of the above curves develops some rather interesting features. In the first place, the general character of the curve of wave-making resistance is the same for each particular model at the different drafts. In general the model with the long middle body and fine ends has a more "wavy" character than that where the ends are fuller with a gradual increase to the midship section. The resistance curve for the model with the fine bow and full stern has somewhat the character of the two extremes, with the result that the curve becomes somewhat flatter than that for the two fine ends.

Froude has shown from experiments upon the effect of increasing the length of parallel middle body, but keeping the ends constant, that these points of maximum and minimum resistance correspond to the cases where the hollow or crest of the transverse wave system occurs at about the middle of the after body. The same appears to be true in the case of the vessel with the fine ends and long middle body, and the reason that the transverse system is more pronounced in this case, as compared with the model with full ends, seems to be that the somewhat abrupt change of curvature at the point where the middle body stops, causes an additional wave crest at this point. The same is true, though to a less extent, at the after end of the middle body, so that on the whole, instead of the bow system of transverse waves dying away gradually from the bow, there are two points situated at about 30 percent of the length from each end, where it receives, as it were, a fresh impetus. If, however, the after body from the midship section be replaced by the gradual form with the fuller end (1B 3S) the transverse system becomes much flatter in the after body, and hence, until high speeds are reached the height of the wave crest or hollow, occurring at the middle of the after body, is too small to have any appreciable effect. The above will explain the somewhat high resistance which the form with the fine ends experiences at the low speed-length ratios, as compared with that where the ends are fuller; and also may help to explain the fact that the form with the fine bow and fuller stern (1B 3S) is easier to drive than that where both ends are fine (1B 1S).

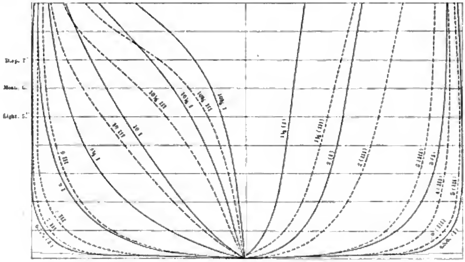
In comparing the two forms of bow, the influence of the fine lines forward as compared with the more rounded and fuller ones is most marked. The sharp angle of the forward waterlines reduces the wave making considerably, the fuller form tending to pile up a much more pronounced system at the bow. Taking the two extreme cases, *i. e.*, the best and the worst form, 1B 3S and 3B 3S, the comparative wave-making resistance at about the practical speeds for the particular type of vessel are as follows:

COMPARATIVE WAVE-MAKING RESISTANCE.

$\frac{V}{\sqrt{L}}$	Light Draft.	Medium Draft.	Deep Draft.
0.6	1.0 : 1.448	1.0 : 1.21	1.0 : 1.457
0.65	1.0 : 1.715	1.0 : 1.57	1.0 : 1.545
0.7	1.0 : 2.150	1.0 : 1.945	1.0 : 1.75
0.75	1.0 : 2.130	1.0 : 1.925	1.0 : 1.68

* Read before the Society of Naval Architects and Marine Engineers, New York, Nov. 21, 1907.

FIG. 1.—SECTIONAL AREAS AT FULL DRAFT OF THE THREE MODELS TESTED.



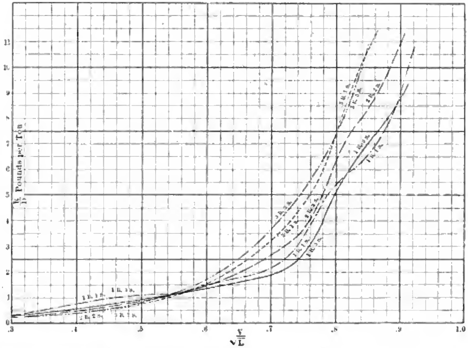
BODY PLANS OF FORMS I AND III, ILLUSTRATING LONGITUDINAL DISTRIBUTION OF DISPLACEMENT.

COMPARATIVE TOTAL RESISTANCES.

$\frac{V}{\sqrt{L}}$	Light Draft.	Medium Draft.	Deep Draft.
0.6	1.0 : 1.075	1.0 : 1.053	1.0 : 1.055
0.65	1.0 : 1.16	1.0 : 1.14	1.0 : 1.13
0.7	1.0 : 1.26	1.0 : 1.222	1.0 : 1.20
0.75	1.0 : 1.305	1.0 : 1.262	1.0 : 1.20

From the above table it will be seen that between the best and worst form there is a difference in wave-making resistance of nearly 100 percent at about the normal speed for the type of vessel, and a difference in total resistance of from 20 to 30 percent.

At the low speed-length ratios, the more gradual forms seem to give the best results, with the result that the mean form (No. 2) shows the smallest resistance up to a speed-length ratio of about 0.5. This is doubtless due to the easing away



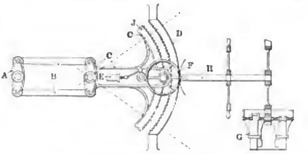
RESISTANCE CURVES OF FIVE MODELS AT THE MEDIUM DRAFT.

of the somewhat abrupt shoulder that occurs on the No. 1 forms. When, however, the higher speeds are reached, the influence of the finer bow becomes at once manifest. It should be borne in mind, however, that if a vessel were to be driven at a maximum speed-length ratio of from 0.6 to 0.65, the form adopted would be considerably fuller as a rule than that of the present series.

It is interesting to note that no matter what distribution of form is used in this particular type, when a speed-length ratio of anything over 0.7 is desired the resistance is increasing very rapidly. In fact, the limit of economical speed for this type seems to be about 0.725.

The forms with the full bows have a much more pronounced bow wave, the crest appearing practically at the bow. The system, however, has largely dissipated before reaching the stern, and there is no very pronounced wave in the after body, no matter what form of stern is used.

Although it is not safe to draw general conclusions, the results of the above experiments for this particular form may be summarized briefly as follows: With a given set of dimensions, length, breadth, draft and with a given displacement, it is advantageous, so far as the forebody is concerned, to use a comparatively long middle body and fine bow. In the after body, however, better results seem to be obtained by adopting a form with a more gradual diminution of area from the midship section aft. The action of the propeller should not be lost sight of in the design of the after body, but in the series under discussion it will be noticed that the form of the after body and shape of the waterlines give a fairly easy form, even in the case of the fullest shape.



STEERING GEAR OF THE PRINZESS ALICE.

same connecting by two pipes with another cylinder in the steering engine room, where it operates the controlling valve of whichever engine may be running.

The operation is differential and reciprocal, *i. e.*, the movement of the rudder is automatically proportional to the movement of the wheel, and if the rudder be moved from the steering engine room, or some other part of the ship, or by the sea, the wheel will move also. In other words, the quartermaster "feels" his rudder and its movements very much as if the ship were a small yacht; which, as any seaman knows, is of greatest assistance in rough weather or in holding a close course in a heavy swell.

A less important and more common detail is the placing of all this gear rather forward on a false tiller *C*, where the ship is more roomy and stiffer, the false tiller being connected with the tiller *A* by two parallel heavy links *B* in a well-known manner.

THE GERMAN BATTLESHIP POMMERN ON TRIAL TRIP, AUGUST 24, 1907.

Steering Gear of the Prinzess Alice.

This gear is of peculiar interest because of its novel design and excellent features. Its two main features are independent spare power and a practically certain control from the bridge that absorbs very little power.

On the tiller is a twin steam engine *E*, which operates through a train of gears on a stationary rack *D*, thus swinging the tiller in either direction. Also on the tiller is a moving rack *J*, by which a separate or spare engine *G* operates the tiller through the shaft *H* and the spur wheel *F*. This gives a very compact and reliable arrangement; but the usual objection of a steering gear placed aft applies, *i. e.*, the control from the bridge, if electric is not perfectly reliable, if mechanical, is laborious and slow. In this case the wheel on the bridge operates a piston in a cylinder full of glycerine,

It is impressive to marine men to note the ease with which this gear works, the silence, even when traveling hard over, and the absence of groaning ropes, etc. Instead of the usual stops, which break up gear and steering engines when putting her hard over, the engine merely runs off the rack, and the rudder strikes a bumper. The engine is provided with a governor, set to prevent excess speed. These, it is believed, form some unique features in steering machinery.

The ship, which belongs to the North German Lloyd Company, measures 523 feet 5 inches in length by 60 feet 1 inch beam and 34 feet 7 inches depth. Her net tonnage is 6,721 and gross tonnage 10,911. She was built by the Aktien Gesellschaft Vulkan, at Stettin, in 1900. Propulsion is by twin screws, operated by quadruple expansion engines with cylinders 27½, 40, 57½ and 82 inches, and a stroke of 55 inches.

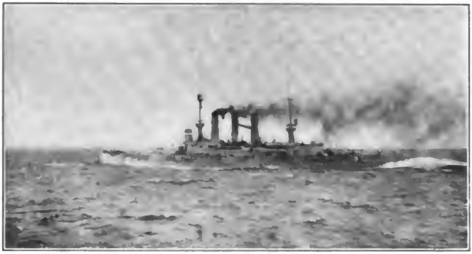
The Trials of the German Battleship Pommern.

This ship, which was launched in December, 1905, is one of the *Deutschland* type, with a displacement of 13,000 tons, and designed for a speed of 18 knots, with 16,000 horsepower applied to three screws. The length between perpendiculars is 398 feet 6 inches, with a beam of 72 feet 10 inches, and a draft of 25 feet. Provision is made for the carrying of 700 tons of coal at a normal displacement, which may be increased to 1,600 tons with bunkers full, besides which 200 tons of oil may be carried.

The military features include a battery of four 40-caliber 11-inch guns mounted in pairs in turrets on the center line, forward and aft; fourteen 40-caliber 6.7-inch rapid firing guns; twenty-two 3.4-inch guns; fourteen 1-pounders; four machine guns, and six submerged torpedo tubes. The armor belt has a maximum thickness at the waterline of 9.45 inches, decreased to 3.94 inches at bow and stern. The heavy guns are protected by 11 inches of armor, and the lighter primary guns by armor from 5.9 to 7.87 inches in thickness.

In a 6-hour forced draft trial Sept. 13 a speed of about nineteen knots was obtained, the horsepower being 18,697, with 118 revolutions per minute, an air pressure of 0.9 inch, and a coal consumption per indicated horsepower per hour of 1.61 pounds. The next day a maximum speed of 19.26 knots was reached at 122.8 revolutions per minute, and 20,348 horsepower (Admirality coefficient 194). On Sept. 17 a 24-hour trial was run, in which the center screw was allowed to run idle, propulsion being by means of the two side screws. With 3,464 horsepower, the speed was 10.88 knots (Admirality coefficient 205.5), while the coal consumption was 1.59 pounds per horsepower-hour.

Our photographs are snapshots taken by a Glasgow reader, on the occasion of a preliminary trial, Aug. 24, 1907.



BROADSIDE VIEW OF THE POMMERN RUNNING AT FULL SPEED.

A Mammoth New Atlantic Liner.

There is under construction in the Belfast yard of Harland & Wolff an immense passenger steamer for the Hamburg-American Line which has many points of interest entirely aside from its size. A principal feature is the fact that this ship is to be fitted with a combination of reciprocating and turbine machinery, there being provided three screws, of which the two outer ones are actuated each by a quadruple expansion steam engine, while the center shaft is turned by a low-pressure steam turbine, the steam for which is given by the exhaust from the piston engines. The total horsepower will be somewhere in the neighborhood of 30,000, giving an estimated sea speed of 20 knots. It is reported that a swimming tank, 25 by 75 feet, and a tennis court are to be provided.

The principal dimensions of this ship show a length over all of 804 feet, a length between perpendiculars of 758 feet, a beam of 88 feet, and a depth to the upper deck of 63 feet 9 inches. It will be noted that the length over all exceeds that of the *Lusitania* and *Mauretania* by about 15 feet; the length between perpendiculars is 2 feet short of the Cunarders; the beam is the same, and the depth is more than 3 feet greater. The ship has thirteen watertight bulkheads and five complete decks in the hull, running from bow to stern.

Some of the principal scantling members have been given as follows by *Schiffbau*:

Flat keel, 1½ inches; garboard strake, 1 1/16 inches; bottom strakes, 15/16 inch; bilge strakes, 1 inch, 1 inch and 1 1/16 inches; side plates, 15/16 inch; sheer strake, 1 inch; center line vertical keel, 15/16 inch; double bottom horizontal center plate, 11/16 inch; double bottom side plates, 9/16 inch; upper deck stringer plate, 15/16 inch; inner stringer plate, ¾ inch; middle deck stringer plate, ¾ inch; other stringer plates, 9/16 inch; deck plating on the upper deck, 9/16 inch; on the middle deck, 7/16 inch; on the other decks, ⅜ inch. The depth of the double bottom is given as 5 feet 4 inches, and the frame spacing as 36 inches. The frames are channels measuring 10 by 4 by 4 by 21/32 inches. The deck beams on the upper deck are channels 8 by 4 by 4 by ½ inches. The deck beams on the middle, lower, and orlop decks are channels 10 by 3½ by 3½ by ½ inches. Hold beams measure 10 by 4 by 4 by ½ inches.

Obituary.

Harrison Loring, one of the pioneer iron steamship builders of the United States, died at South Boston, Mass., Dec. 26, at the age of 85. He opened a machine and boiler shop in South Boston in 1847, and in 1857 began the building of iron steamships. Among those which he constructed for the United States Navy were the old monitor *Canonicus* and the small cruiser *Marblehead*.

Commander Harry H. Hosley, U. S. N., died in the New York Yacht Club on Jan. 6. His successful pilotage of the floating drydock *Dewey* from Sparrows Point, Md., to Olongapo, Philippine Islands, was watched with intense interest all over the world.

THE TRANSPORTATION OF REFRIGERATED MEAT TO PANAMA.*

BY ROLAND ALLWORK.

This paper is intended to give a description of what has been done in the way of transportation of refrigerated meats to Panama, for the use of the thousands of men and their families who are located on the Isthmus, to build the greatest of all artificial waterways, known as "The Panama Canal." It is generally known that in tropical climates beef will not keep more than a day or so; it therefore has to be eaten the same day that it is killed. There is therefore a very urgent need for cold storage facilities on the Isthmus. Plans and specifications were made for a reinforced concrete building with 50,000 cubic feet of refrigerated storage.

The next step was to equip the steamers of the Panama Railroad Steamship Line with cold storage. We had at that time five steamers in service on this line: The *Advance* and *Finance*, of 2,600 tons; the *Allianca*, 3,000 tons, and the *Colon* and *Panama* (formerly the *Mexico* and *Havana*, of the Ward Line), 5,600 tons. The *Mexico* was the only steamer that was equipped with mechanical refrigeration.

On the latter steamship the cold storage for cargo was located on the orlop deck, aft of the engine room. The system of refrigeration was the ammonia compression system. The compressor, condenser, brine tank and brine pump were located in a small room marked "Machinery," leading out of the main engine room. The plant is what is rated as a 3-ton plant. It consisted of a duplex compressor 4 by 9 inches, operated by a single engine, 7-inch diameter cylinder, 7-inch stroke, an inclosed condenser and inclosed brink tank.

In commercial refrigerating or ice machines there are four principal refrigerants used—ammonia, carbonic gas, sulphurous acid and air. I will not go into the relative merits of these refrigerants, but ammonia was chosen because it is most generally used by packing houses, and we did not wish to deviate from the well-trodden path. Of the several ammonia systems in use, the ammonia compression system with cold brine circulation is the best suited for ship refrigeration, and this system was therefore installed on our boats.

This system consists of the following parts: Ammonia compressor; ammonia condenser; ammonia receiver; brine cooling tank; brine circulating pump; brine cooling coils in cold storage rooms. The process of refrigeration is as follows:

The liquid anhydrous ammonia is allowed to expand from the ammonia receiver into the coils of the brine cooling tank. In expanding from a liquid into a gaseous state in these coils, the ammonia cools the brine surrounding the coils to a low temperature. From the coils in the brine cooling tank the ammonia gas is drawn into the compressor, where it is compressed and forced through the ammonia condenser, in which the hot, dense gas from the compressor is cooled off to the temperature of the cooling water and returned again to the receiver in its liquid state, ready to be again expanded into the brine cooling coils, thus repeating its circulation over and over again. The cooling water in the condenser takes away from the ammonia the heat which it has acquired during compression, and also absorbs the heat transferred to the ammonia while producing refrigeration in the brine cooling coils.

The brine part of the plant operates as follows:

The body of brine contained in the brine tank is cooled by the ammonia coils in the tank. This cold brine is taken from the bottom of the brine tank and by means of a pump is circulated through the cooling coils in the cold storage room, and then again discharged into the top of the brine tank. The temperature of the brine leaving the coils will be several degrees higher than the initial temperature of the brine, but in the brine cooling tank the brine is again lowered to its initial temperature. Salt or chloride of calcium can be used for the brine, but the latter is preferable on account of its lower freezing point, and its non-corrosive action on the pipes.

In place of the brine cooling tank and the submerged condenser used on the steamers *Colon* (*Mexico*) and *Panama* (*Havana*), we have installed on the steamers *Advance* and *Finance* a double-pipe brine cooler and double-pipe condenser, which possess some advantages over the former. In the brine cooler plants, the brine is pumped through the cooler, where it is cooled by the ammonia, and from there it passes through the cooling coils in the cold storage room, and is then discharged into a brine return tank. From the brine return tank the pump takes the brine and again passes it through the brine cooler and coils, repeating the above operations over and over again.

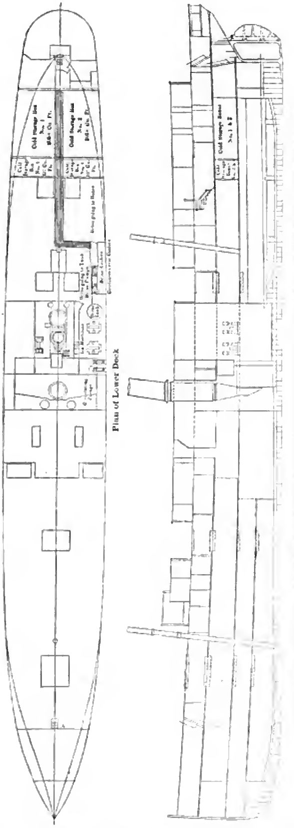
The brine coolers used on the *Advance* and *Finance* are of the double-pipe, or pipe-within-a-pipe type, each consisting of one coil of 3-inch and 2-inch ammonia pipe, 6 pipes high and 18 feet long. Each cooler contains in all 108 lineal feet of 2-inch pipe = 67 square feet of cooling surface. The refrigerating capacity of each cooler is 8 tons. The 2-inch pipe is placed within the 3-inch pipe, the ammonia expanding in the annular space between the two pipes, and the brine circulating through the inner 2-inch pipe. This type of brine cooler is very effective, takes up comparatively little room, is easily repaired and is always accessible for inspection.

Another type of brine cooler much used is the shell cooler, consisting of a strong wrought iron or cast iron shell, with a number of spiral coils placed inside the shell. The ends of the coils pass through the top and bottom heads of the shell, and are connected to headers. The ammonia is expanded into the lower part of the shell, and the compressor takes the ammonia gas from the top of the shell; the brine enters the spiral coils at the top and passes out at the bottom. This type of cooler has some points of advantage over the double-pipe type. The ammonia gas in the shell completely envelops the brine coils and remains a long time in contact with them, and as the shell area is very large compared with the small annular ammonia space in the double-pipe cooler, the gas meets with much less frictional resistance. The shell cooler also takes up less floor space than the double-pipe cooler, but it requires more head room, is less accessible for repairs and inspection, and the first cost is greater.

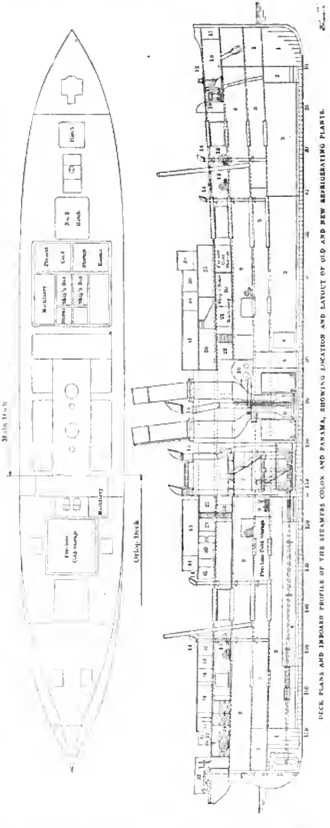
A brine system equipped with an outfit of the above-mentioned brine coolers, while practically having all the advantages of the direct expansion system, has none of the disadvantages of the latter system. It will produce refrigerating results almost as quickly as the direct expansion; it is more safe, as all the ammonia parts are confined in one place, and no ammonia is circulated in the cold storage rooms. It is more simple to operate and to control, and a more even temperature can be maintained in the rooms. In case of stoppage of the compressor, there is always a supply of cold brine on hand in the brine cooling tank, or brine return tank, to run the plant for some time. This is not possible with a direct expansion plant, and the refrigeration ceases immediately when the machine stops.

The brine return tanks on the *Advance* and *Finance* have a sufficient storage capacity to maintain a temperature in the rooms, with a very little loss, for about four or five hours, should the machine have to be stopped for any reason. The condensers on these ships are also of the double-pipe type, of precisely the same construction as the cooler before described. Each condenser consists of one coil of 2-inch and 1¼-inch pipe, six pipes high by 19 feet long. The total number of lineal feet of 1¼-inch pipe in the condenser is 114 feet = 50 square feet of cooling surface. Condensers, each 7½ tons refrigerating capacity.

* Read before the Society of Naval Architects and Marine Engineers, New York, Nov. 22, 1907.



DECK PLAN AND LONGITUDINAL SECTION OF THE STEAMERS ADVANCE AND FINANCE, SHOWING LOCATION AND LAYOUT OF THE NEW REFRIGERATING PLANT.



DECK PLANS AND INBOARD PROFILE OF THE STEAMERS COLON AND PANAMA, SHOWING LOCATION AND LAYOUT OF OLD AND NEW REFRIGERATING PLANTS.

1, Trimming Tank (Magazine). 2, Chain Locker. 3, Cargo Space. 4, Fresh Water Tanks. 5, Coal Bunker. 6, Boiler Room. 7, Engine Room. 8, Shaft Alley. 9, Dynamo Room. 10, Donkey Boiler. 11, Steam Windlass. 12, Steam Capstan. 13, Steam Winches. 14, 15, 18, Ventilators. 17, Stores. 18, Crew Space. 19, Hatch. 20, Ice House. 21, Stores. 22, First-Class Galley. 23, Baggage. 24, Steerage. 25, First-Class Dining Saloon. 26, Pantry. 27, Specie Room. 28, Stewardess. 29, Linen. 30, 31, First-Class Lavatory and Bath. 32, Second-Class Dining Saloon. 33, Pantry. 34, Second-Class Quarters. 35, Lavatory. 36, Steerage Companion. 37, Steering Engine. 38, Pilot House. 39, Captain. 40, Officers. 41, Social Hall. 43, Smoking Room. 44, State Room.

The ammonia gas passes through the annular space between the 2-inch and 1¼-inch pipe, and the circulating sea water is passed through the 1¼-inch inner pipe in the opposite direction to the ammonia, thus producing a counter-current effect, which cools the ammonia gas in the most effectual manner, keeps it in intimate contact with the cooling surface, and discharges the cooling water within a few degrees of the temperature of the gas. This type of condenser will therefore use less water, and requires considerably less cooling surface, than any other type of condenser.

The only objection to this type of condenser is that sea water in time fouls the pipes, and we find it somewhat troublesome to clean these pipes, but I understand that in later types of double-pipe condenser this objection has been overcome, and the water pipes can now be easily and quickly cleaned without disturbing any ammonia joint.

One of the drawings shows the construction of the double-pipe condenser. The brine cooler is constructed in the same manner, but uses larger pipes. I also show in one of the drawings attached with this paper a plan of an inclosed submerged condenser used on the *Mexico* and *Havana*, which explains itself. The condenser of the refrigerating plant of the *Mexico* was larger on account of its being a larger plant, but this shows the type used, and this also applies to the cooling tanks, which are constructed in the same way, but which are larger. The condenser consists of a cylindrical shell of steel plate, 4 feet 2 inches diameter and 4 feet 8 inches high, with two coils of 1¼-inch diameter extra heavy pipe, the total lineal feet of coil being 450. The ammonia is pumped through the coils, and the water circulates in the tank on the outside of the coils.

The brine cooling tank was constructed in the same way, except that it was larger and had three coils instead of two—dimensions being 5 feet diameter, 5 feet 8 inches high, 900 lineal feet of 1¼-inch pipe coils. In this tank, the ammonia expands through the coils, cooling the brine in the tank surrounding the coils. There was one cold storage room, with the brine coils on the walls and ceiling.

The first plant was used by the Ward Line to carry meat to Cuba, and had from the information received given every satisfaction. For the purpose of the Panama service it had also some defects, the principal ones of which were the location of the cold storage room, which was, as before stated, away down in the hold, and the fact that the room was not sub-divided, thereby requiring the carrying of only one temperature for all commodities.

The *Havana* was at this time undergoing repairs in New York, and instructions were given to equip her with mechanical refrigeration of the same capacity as the *Mexico*. The most convenient location for the cold storage on this ship (which is a sister ship to the *Mexico*), was found to be on the main deck aft of No. 2 hatch; there was just room enough to erect two cold storage rooms, with an aggregate capacity of 3,000 cubic feet (the same capacity as the one room in the *Mexico*), and orders were given to proceed with the work on this basis. The advantages of this location were found to be twofold.

In the first place, it enabled the delivery of meats and vegetables immediately upon the ship's arrival in port, without waiting for the cargo out of the hold to be discharged first, and in the second place it easily enabled us to pipe the ship meat boxes, which were located directly aft of these rooms, and which were formerly cooled with ice. The ship's boxes were originally designed only large enough for the run from New York to Havana, and were not of sufficient capacity for a run from New York to Colon, approximately twice the distance. By using brine pipes instead of ice it increased the capacity of the ship's boxes. The brine pipes used were 2-inch galvanized pipes, and the ratio of cubic feet of refrigerated space to lineal feet of 2-inch pipe was 2.6 to 1 or 4.4 cubic feet of refrigerated space to one square foot of cooling surface.

The machinery was an exact duplicate of that in the *Mexico*, but instead of being located in the engine room, as in the *Mexico*, it was located on the port side, aft of the refrigerated rooms. The advantage of this location was found to be so apparent that new cold storage rooms were afterwards built on the *Mexico*, similar to those on the *Havana*. A 5-ton plant was, however, put on the *Mexico* instead of a 3-ton plant, as it was found that the 3-ton plant was operated nearly to its limit. The machinery was of the same type.

The insulation of the cold storage rooms consisted of matched spruce boarding, with the inner space packed with spruce shavings. Spruce was used, as it gives no odor; and the shavings do not "pack" or shake down like sawdust, as their elasticity keeps them in place. The shavings were short, and were made by an ordinary rotary planer, and I consider it, when cost is taken into consideration, the most efficient insulation that can be adopted. There is one disadvantage, however. It requires a thicker wall (over twice the thickness) than cork insulation of the same efficiency, and great care must be taken to prevent moisture getting into the insulation, as this will quickly destroy its insulating qualities. It is, however, more economical in the first cost than cork blocks.

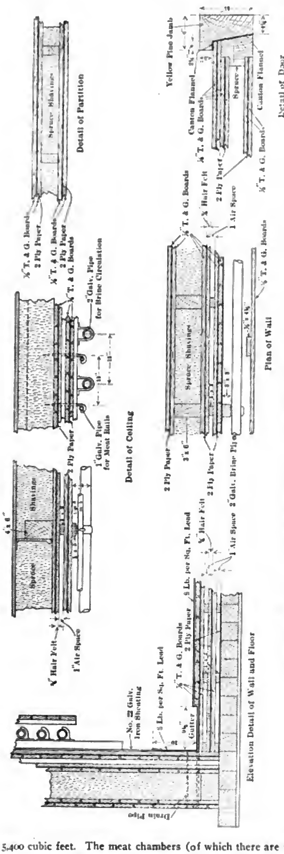
The cargo refrigerating rooms consisted of two rooms, each of the same dimensions and similarly piped with 2-inch galvanized iron brine coils. The brine pipes were in two groups in each box, that is, with a separate supply and return for each; one group was on the ceiling and the other on the walls. The rooms were piped the same so that, should occasion require it, either or both boxes could be used for the meat. The meat rails are 11 inches center to center, and are of 1-inch galvanized pipe. They are supported by long screwed hooks, screwed into 6 by 4-inch yellow pine timbers, which are bolted to the deck beams. The meat is carried on galvanized hooks, hung on the meat rails. The brine pipes are supported by galvanized iron clips on the ceiling, and by pipe brackets on the walls.

The floor is covered with 8 pounds per square foot of sheet lead, the planking forming the floor being doubled in the center in order to form a depression or gutterway 10 inches wide all around the edge, the gutter draining out through a pipe at the side of the house, which drain was plugged outside when the water had been drained off.

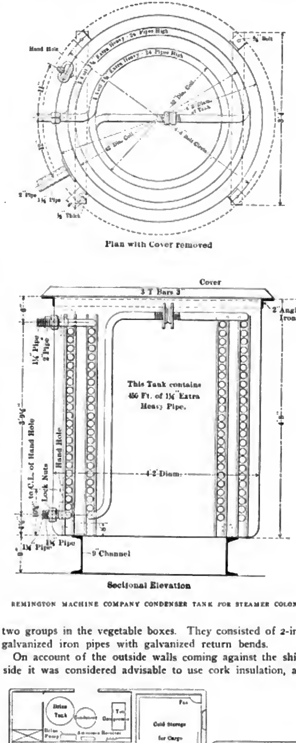
In the fruit and vegetable room it was found that some of the fruit and vegetables during one voyage showed signs of getting bad. This was due to moisture, and was remedied by putting two 12-inch electric fans in galvanized chutes or casings, so as to deliver a current of air around the brine coils, and between the walls and apron, the purpose being to condense the moisture in the air over the coils, and carry it away in the gutter. After this means was adopted there was no trouble with bad fruit or vegetables. But I have come to the conclusion that if the fruit and vegetables are received in a not over-ripe condition, and if the door of the refrigerated room is not opened too often on the voyage, there would be no need of a fan, as they have been so carried without injury on the *Advance* and *Finance*.

The need for good wholesome meat on the Isthmus was so urgent that it was necessary to carry it on the next incoming ship. The necessary machinery and material was purchased, and in five days after the ship's arrival one of the rooms was built and piped, and the meat stowed. Although so short a time was taken, the only part of the work that was omitted was the galvanized iron lining, which was put in upon the ship's return to port. The brine pipes in this room, of course, had to come down to do this.

Instead of 3,000 cubic feet capacity (as on the *Mexico* and *Havana*) it was decided to put in much larger capacity on the *Advance* and *Finance*. The capacity on these ships was made



INSULATION DETAILS OF THE NEW REFRIGERATING PLANT (COLD STORAGE ROOMS) ON THE STEAMERS COLON AND PANAMA.

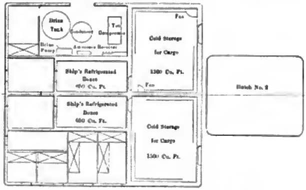


REMINGTON MACHINE COMPANY CONDENSER TANK FOR STEAMER COLON.

5,400 cubic feet. The meat chambers (of which there are two) were aft, and the fruit and vegetable chambers forward, forming vestibules to the meat chambers.

The brine pipes were in three groups in the meat boxes, and two groups in the vegetable boxes. They consisted of 2-inch galvanized iron pipes with galvanized return bends.

On account of the outside walls coming against the ship's side it was considered advisable to use cork insulation, and

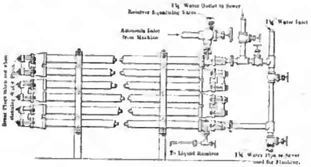


PLAN OF THE COLD STORAGE PLANT ON THE COLON AND PANAMA.

in order to simplify construction, cork was then decided on for walls, ceiling and floor. The ship's side was wire-brushed clean, and two coats of white lead and zinc were put on and cork dust thrown on it while it was wet. A layer of granulated cork was then put in the spaces between the frames. In these chambers the floor was covered with lead similar to that in the *Mexico* and *Havana*, with a gutter all around, but this deck being below the waterline, the drains were carried into the bilges.

In considering the most important points in the construction of the rooms, I would say that it is important to get the joiner work carefully done, also the cork sheets (which are 2 inches thick), cut square and properly butted; in fact everything to prevent the circulation of air or the admission of moisture. The galvanized iron lining should be 24 gage, lock seamed; in these cases it was also soldered, but I do not think that this added to its efficiency.

The pipe hangers should be wrought or malleable iron galvanized, but I do not know that it is necessary to use galvanized pipe for brine coils, as the life of the pipe is limited to the life of the threads, and the threads in galvanized pipe do not last longer than the threads in black pipe. I would, however, recommend that, if black pipe is used, it be cleaned and given a thin coat of graphite to protect it. The meat rails should be galvanized whether pipe or bars are used.



DOUBLE-PIPE BUFFALO AMMONIA CONDENSER.

The rooms in the *Mexico* and *Havana* were not at first lined with galvanized iron, but the sheathing was shellacked. The meat chambers, however, have since been lined on the walls, as it is found easier to keep clean. In the *Mexico* and *Havana* the cold storage rooms, being on the main deck with plenty of light and air, are not hard to keep clean and in good order, even though the walls are of spruce sheathing. In the *Advance* and *Finance*, the rooms being below decks, it was considered advisable to line them as before stated with galvanized iron, so that a hose can be played on the walls and ceiling when the meat has been discharged, and the grating taken up and scrubbed.

The machinery on the *Advance* and *Finance*, which are identical, consists of two 7½-ton refrigerating machines, each having a 6-inch diameter by 12-inch stroke double-acting ammonia compressor, and a 9 by 12-inch steam engine; two double-pipe ammonia condensers, each of 7½ tons refrigerating capacity; two double-pipe brine coolers, each of 8 tons capacity; one brine return tank. Only one compressor, one condenser and one brine cooler is used, the other being held in reserve in case of accident.

There are two brine pumps and two circulating pumps for the condensers; only one of each is used, the other being held in reserve in case of accident. The size of each brine pump is 6 and 4 by 6 inches; of each circulating pump 6 and 5¾ by 6 inches.

The ratio of cubic feet capacity to lineal feet of 2-inch pipe in the cold storage room was 1.58 to one in the meat chambers; and in the fruit and vegetable chambers about the same. It was considered advisable to cover all the walls and ceiling with brine coils, and not to be governed too much by ratios, so as to get an even distribution of cold and to regulate the temperature in the chambers by the amount of flow of brine through the coils.

We have been fortunate enough never to have had a breakdown, and the provisions have arrived at the Isthmus in good condition. There are two refrigerating engineers carried on each steamer, and they stand six-hour watches. These ships, however, carry barely enough for the immediate needs of the Isthmus; it will, therefore, be necessary to carry periodically larger quantities, in regular refrigerated ships, so as to stock the cold storage building at Colon, our steamers being capable of keeping up the stock probably for three or four months.

The Austrian Steamer Marina.

The steamship *Marina*, built by Robert Stephenson & Company, Limited, Hebburn-on-Tyne, to the order of the Navigazione Libera Triestina Società in azione, of Trieste, has undergone successful loaded trials and departed for Trieste, her port of registry. She has been built to take the highest class under Lloyds registry and the Austrian Veritas, and is of the single decked type, with no hold beams—her holds thus being clear of obstruction to stowage. She has been fitted with a steel center line bulkhead in lieu of hold pillars, while portable wooden grain boards are fitted in her hatchways, so that she may be available for taking bulk grain cargoes.

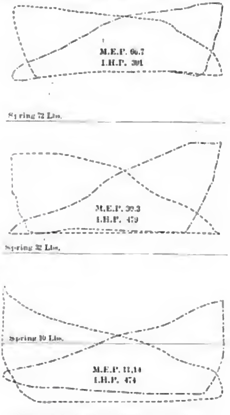
A cellular double bottom all fore and aft with dry well under boilers, and a large after peak tank extending to the upper deck, are fitted for water ballast, holding in all about 840 tons of salt water. Large hatchways are fitted over the four main cargo holds, with strong coamings of sufficient depth to hold 2 percent of the capacity of the compartment they feed, thus complying with the bulk grain carrying regulations, and a complete outfit of powerful steam winches and cargo derricks, with patent blocks and flexible steel wire runners, has been installed for working them. The cargo capacity is very large, being about 58 cubic feet per ton of deadweight. The vessel's dimensions are 317 feet 6 inches in length, 46 feet 6 inches molded beam, and 23 feet 3½ inches molded depth, and she has been designed to carry a large deadweight (4,700 tons) on a light draft.

A large and commodious steel deck house has been fitted on the forward end of the bridge deck, in which are placed the dining saloon, captain's cabin, two spare cabins, bathroom and toilet, also the steward's pantry and storeroom and steward's berth. The ship's officers and engineers are berthed in steel deckhouses built as part of the engine casing, above bridge deck, with doors in a passage entered from the after end, so as to be entirely sheltered in bad weather. The seamen and firemen are berthed under the topgallant forecastle, a separate house being provided for each class.

The machinery has been built by Richardsons, Westgarth & Company, Limited, at their Scotia Engine Works, Sunderland. The cylinders are 23, 38 and 62 inches in diameter by 42-inch stroke. The high-pressure cylinder and the high-pressure piston valve have separate hard cast iron liners. The go-ahead and go-astern guides are carried on independent front and back cast iron columns. The crank shaft is in three interchangeable parts, and is made of ingot steel throughout, while the bedplate is sufficiently deep to be bolted direct on to the tank top, without intermediate built-up seating. The all-round reversing gear is driven by an independent steam engine, the latter also, by means of patent link chain, operating on the turning gear. Every bearing throughout the engine is adjustable and easily manipulated while the engine is running, and all the white brass used in the engine and thrust block is of the finest quality.

The surface condenser is provided with large steam space and cooling surface; all the tubes are packed with cotton packing and close ended screwed brass ferrules. The pumps are worked from the intermediate engine crosshead by means of steel plate levers, and, although long links connect the levers to the pump crosshead, an independent adjustable guide is also fitted. The air pump is single acting, with brass valves; the circulating pump being double acting and with india rubber valves, while both feed and bilge pump rams, valves and chests of gunmetal throughout, and the bilge pump doors are easily removable without the aid of spanners. Duplex feed pumps with gunmetal water ends are fitted for harbor work, while a large ballast pump, connected to pipes and valves of fully twice the usual size, enables water ballast to be discharged quickly.

THE STEAMSHIP MARINA MAKING 10¼ KNOTS ON TRIAL TRIP.



INDICATOR CARDS FROM ENGINE OF MARINA.

Steam is supplied by two Scotch boilers 15 feet in diameter by 10 feet 6 inches long, containing 4,200 square feet of heating surface, and fitted each with three patent corrugated and withdrawable furnaces. They operate at 160 pounds pressure. All the machinery has been built to pass Lloyd's special survey. The boilers and steampipes are covered with S. T. Taylor & Sons' "Tynos" non-conducting sheathing.

During the trial trip, April 19, the engines worked with perfect smoothness, and gave great satisfaction to both owners and builders. The tracing of the cylinder diagrams taken during the trials shows a total horsepower of 1,344, on 66½ revolutions per minute. The speed was 10¼ knots with a half cargo aboard.

Clyde-Built Steamers for Canadian Lakes.

The Fairfield Shipbuilding & Engineering Company, Ltd., Glasgow, launched, last summer, within a few days of each other, two interesting vessels for the Canadian Pacific Railway Company's service on the Great Lakes. The vessels are named *Assiniboia* and *Keewatin*, and as they are sister ships, a description of one applies to the other also. The principal dimensions are: Length, 348 feet; breadth, 43 feet 6 inches; depth 26 feet 9 inches to awning deck; gross tonnage, 4,300. Each is divided into seven watertight compartments. There are four decks; main, awning, promenade, and hurricane deck.

The fore part of the ship is divided into three compartments for the carrying of grain or other cargo, the former to be put on board through trunked hatches from the hurricane deck. The working of the cargo is accomplished by means of an overhead revolving shaft 140 feet in length, driven by a double-cylinder steam-hoisting engine with two revolving drums, with clutches to each of the five hatches to insure rapid manipulation.

Powerful appliances for working the vessel include a large windlass and capstan forward, and two warping capstans aft.

The propelling machinery consists of a single quadruple expansion engine having four cylinders working on four cranks, balanced on the Yarrow, Schlick & Tweedy system. The high-pressure and first intermediate cylinders are fitted with piston valves; and flat valves of the double-ported type are fitted to the second intermediate and low-pressure cylinders; all worked by the usual double-eccentric valve gear, controlled by steam gear of the all-'round reversing description. The crankshaft is of the built-up type, and (as also the thrust and propeller shafting) is of forged mild ingot steel. The propeller has four blades of cast steel secured to a boss of the same material.

Water is circulated through the condenser by an independent centrifugal pump, having also a suction to the engine-room bilge to enable a large quantity of water to be pumped out of the ship in case of need. Independent air, bilge and sanitary pumps are fitted for boiler-feed, ash ejectors, ballast and general service purposes, and in the engine room there are a feed heater and a feed filter.

The four boilers are of the cylindrical return tube type, and are arranged to work with natural draft. They are constructed entirely of steel, for a working pressure of 220 pounds per square inch. An ash ejector is fitted in each stoke-hold.

The entrance to the passenger accommodation is on the main deck, amidships, where is a large spacious hall with two staircases. The entrance hall is panelled in teak, with ornamental balustrade to the stairs, and the floor is laid with interlocking rubber tiles. Forward of the main entrance is the package freight deck, access to which is obtained by large double doors through the ship's side.

The awning deck is arranged for the accommodation of 195 first-class passengers in two and three-berth rooms, fitted with patent folding berths, sofa berth, wash basin with running water, etc. Aft of the main staircase are five cabins-de-luxe, panelled in mahogany and oak, with large brass bedsteads, folding lavatory and sofas, and private bathrooms. The chief feature of the awning deck is a large central hall, about 140 feet in length, tastefully furnished with settees to match the surrounding framing.

On the promenade deck is another spacious hall in a large deckhouse, with a well in the center which gives light to the central hall below. On either side there is accommodation for seventy first-class passengers, in three-berth staterooms, furnished similarly to the staterooms on the awning deck. Large windows are fitted with venetian blinds and curtains, which can be left open in any weather. The drawing room is at the fore end of this deckhouse, and is tastefully finished in white enamel and gold. The main feature of this room is the formation of the sofa seats, which are arranged in bays, forming "cozy corners," with seats upholstered in frieze velvet. Writing tables and easy chairs are also fitted.

Amidships, immediately abaft the hall, is the dining saloon, capable of seating 116 persons. The framing is finished in American walnut, with Italian walnut panels. Large rectangular beveled glass horizontal sliding windows, together with a large dome skylight overhead, give ample light and ventilation. The floor is laid with polished oak parquetry with walnut border. Handsome sideboards are fitted to match the framing.

The smoking room is at the after end of the deckhouse, and is designed in light fumed oak with carved panels. Chairs and tables are in oak to match, and the sofa seats are upholstered in Morocco leather. The floor is laid with terra-cotta and white interlocking rubber tiles. Between the smoking room and the dining saloon are the pantry, galley, and cold chambers, with all the latest facilities for catering to a large complement of passengers. The public rooms and the accommodation throughout the vessel are fitted with ornamental vertical radiators, each of which can be independently regulated.

The hurricane deck is 275 feet in length and forms a spacious promenade, to which access is gained by stairways at the fore and after ends. At the forward end of this deck there are the captain's and officers' rooms, and wheelhouse with flying bridge over. Eight steel lifeboats are fitted under davits, in compliance with the steamboat inspection act.

The vessels represent an interesting piece of work, on account of the fact that they have been specially constructed so that on reaching the other side of the Atlantic they might be divided amidships into two parts, each part being towed separately through the canals which lead to the Great Lakes,

THE ASSINIBOIE JUST AFTER BEING CUT IN TWO IN LEVIS DRY-DOCK.

where the sections could be again rejoined. As the lock of the Canadian canals are not of sufficient size to contain vessels of the length of these two, it has been necessary to resort to this expedient. Watertight bulkheads have been constructed on either side of the dividing line. The sections had to be towed through a couple of canals (Lachine and Welland), and a lake (Ontario), of about 200 miles in length, before reaching the field of operation.

MECHANICAL DRAFT IN MARINE PRACTICE

BY WALTER B. SNOW.

The first application of the fan blower as a substitute for or as an auxiliary to the chimney appears to have been made early in the last century. It is said that in 1826 John Ericsson fitted the British steamer *Victory* for forced draft by means of a fan, and it is certain that in 1830 the *Corsair* was so equipped by him. At about the same time, in 1827, Edwin A. Stevens, of Bordentown, N. J., arranged a fan for forcing air into the ashpits of boilers on the steamer *North American*. But engine speeds and steam pressures were then low; the demand for accelerated combustion was not urgent, and experience had not been gained in the proper application of fans for forced draft. As a consequence, this economic improvement, which was to mean so much in later days, was adopted to but a limited extent.

The fact that these first applications were made on steam vessels indicates the natural adaptability of the fan for the purpose. It is, therefore, not surprising to find that the arrangement was again taken up, this time by the United States, during and subsequent to the civil war. Extensive tests were conducted by Chief Engineer Isherwood, but there remained still another stage in its progress toward general application, both on sea and land.

The advent of the torpedo boat marked the further introduction of forced draft for marine boilers. In these small, compact vessels tall stacks were out of the question, but strong draft and the utmost steaming capacity per ton of weight were an absolute necessity. From success with these smaller boats it was but a natural step to those of larger size. In 1877 the French government equipped the scout boat *La Bourdonnais* for forced draft, and in 1882 a definite move was made in the British navy by providing fans for the production of draft on the *Satellite* and *Conqueror*.

The general conditions of naval practice which existed at that time, and the immediate results secured by increasing the steam pressure, improving the type of engine and introducing mechanical draft, are set forth in Table I.

TABLE I.—RESULTS OF TRIAL PERFORMANCE OF SIMILAR SHIPS IN BRITISH NAVY

Draft	SHIP	Date	Steam Pressure, Pounds per Square Inch	I. H. P.	Weight of Boilers Tons	Area of Fire Grate Square Feet.	I. H. P. per Square Foot of Grate.	I. H. P. per Ton of Boiler.
Natural Draft, Open Fire Rooms.	*Inflexible*	1878	60	8,183	750	820	10.21	11.22
	Colossus	1883	64	7,492	594	645	11.62	12.61
	Phaeton	1884	90	5,588	462	516	10.23	12.1
Forced Draft, Closed Fire Rooms.	*Howe*	1885	90	11,725	632	750	15.54	18.5
	Rodney	1885	90	9,544	474	567	16.83	20.1
	Mersey	1885	110	6,628	306	399	16.61	21.7
	Scout	1885	120	3,370	174	207	16.28	19.3

The weight of boiler includes water, funnel, uptakes, fittings, spare gear, etc. Steam blast was used in the case of the *Colossus*

Shortly after this, the United States navy again took up this important factor in the design of the modern naval vessel, and introduced forced draft upon all of the vessels of the "new navy." Among the first so equipped was the dispatch boat *Dolphin*. The general design of her three forced draft fans, with cast iron shells, would now look exceedingly cumbersome in view of the present light steel plate construction. From the navy it was but another step to the merchant marine.

On land, the process of development during the past few years has been remarkable. From the under-grate forced-draft system there has been a gradual change to the over-grate induced system, and a combination of the two, until the matter of mechanical draft engages the attention of every progressive engineer in the design of a steam plant. In stationary practice the fan is applied as a substitute for the chimney. In a more restricted sense this is true in the merchant marine, but in the warship, except in the torpedo-boat type, it is usually regarded as an accessory, to be employed only when the ordinary cruising speed is to be exceeded.

Although its simplicity has much to recommend it, the steam jet becomes a competitor of the fan only where economy of fuel receives secondary consideration. Its low efficiency was well shown by a series of tests made some years since at the New York navy yard, whereby it was demonstrated that from 8 to over 20 percent of the steam produced by a boiler was consumed by the jet. In stationary practice the fan seldom exceeds a consumption of 1½ to 2 percent of the steam generated by the boilers to which it is applied; in large plants it is usually far below these figures. On the contract trial of a modern battleship the indicated horsepower of the fire-room blowers may range up to a possible 1¾ percent of the aggregate indicated horsepower of the main engines and auxiliaries.

The ordinary fan wheel is too well known to require illustration. Its action may be well illustrated by whirling a tube about an axis established at right angles to its own and midway of its length. From the open ends the air is thrown outward by centrifugal force, while a partial vacuum is created at the axis of revolution. If an opening be provided at this axis, air will flow in, and thus a constant current through the tube will be maintained.

In effect, a centrifugal fan wheel is a series of such tubes radiating from an open center, each being represented by the space inclosed between two adjacent blades and the side plates. Through each of these channels the air is thrown into the surrounding atmosphere, or into the case which incloses the wheel. For general purposes it is customary to inclose the fan within a spiral case, which provides a constantly increasing area for the passage of air as it approaches the outlet, from which it may be discharged through a pipe to the desired point of final delivery. Curved blades are employed to decrease the noise, rather than to improve the efficiency.

The maximum velocity at which air may be delivered by a cased centrifugal fan through an outlet of proper area is substantially equal to that of the circumference of the wheel, while the pressure created corresponds thereto, being proportional to the square of the velocity. This area, commonly known as the capacity area, depends upon the proportions of the wheel, but in general practice approximately equals one-third of the diameter in inches, multiplied by the width at the rim in inches, as expressed by the formula $\frac{1}{3} DW$. It is usually much less than that of the regular outlet in the casing. If the capacity area is reduced, the volume will be proportionately decreased, the power will decrease, but not in the same ratio, while the pressure will remain substantially constant.

The size of the outlet in the casing is not a function of the capacity area, but is determined largely by the attendant

conditions. But both the volume and the power required will evidently increase with the size of the outlet, being greater with the normal outlet than with that representing the capacity area. This increase, however, will not be proportional to the area, for the pressure and consequently the velocity will be lower with the larger area. The greatest

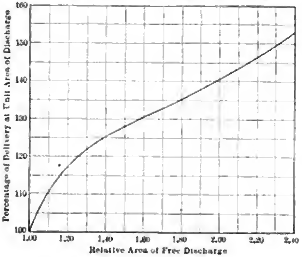


FIG. 1.—RELATIVE DELIVERY OF A CENTRIFUGAL FAN.

delivery of air and the largest consumption of power will occur when the casing is entirely removed and the fan left free to discharge around its entire periphery. The influence of the area of outlet upon the volume discharged is well illustrated by the curve in Fig. 1, presenting the results of tests of a standard fan.

The standard type of fan of medium size usually installed on shipboard consists of a shell of No. 10 or 11 steel plate, with 1½-inch corner angles rolled to the shape of the scroll.

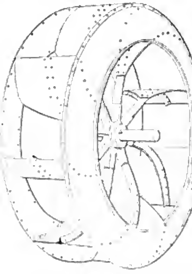


FIG. 2.—TYPICAL FAN WHEEL WITH CURVED BLADES.

The wheel itself is usually built up of No. 12 or 14 gage, and carried upon a hub with 1½-inch or 2-inch T-iron arms cast in. The outlet frame is of cast iron or angle iron, according to the shape and type of fan. The type is illustrated in Fig. 2.

The forced draft fan is almost universally steam driven by a direct connected motor, either in the form of a reciprocating engine, as has been customary in the past, or by a turbine, as in some installations more recently made. A typical fan with double-cylindered engine is shown in Fig. 3.

But as such fans have in the naval service usually been under the direct control of the fire-room force, it is evident that ability to withstand the most ignorant treatment is essential, rather than high efficiency. In the case of the reciprocating engine, the short-stroke double cylinder type was almost universally adopted. The cranks are set at 180 degrees, to give approximate balance of the reciprocating parts, which are entirely inclosed. In the prevailing type of past years, clearance was sacrificed to simplicity, and the steam for the second cylinder passed through the first instead of through independent ports.

In the design of a wheel to meet given requirements it is necessary to make its peripheral speed such as to create the desired pressure, and then so proportion its width as to provide for the required air volume. Evidently, the velocity and corresponding pressure may be obtained either with a small wheel running at high speed, or a large wheel running at low speed. But if the diameter of the wheel be taken too small, it may be impossible to adopt a width within reasonable limits which will permit of the passage of the necessary amount of air under the desired pressure. Under this condition it will be necessary to run the fan at higher speed in order to obtain the required volume. But this results in raising the pressure above that desired, and in unnecessarily increasing the power required. On the other hand, if the wheel be made of excessive diameter it will become almost impracticable, particularly on shipboard, on account of its narrowness. Between these two extremes a diameter must be intelligently adopted that will give the best proportions. In practice the width of a volume fan seldom exceeds one-half its diameter. In a fan for higher pressures than those which obtain in forced-draft practice, the proportion may run as low as one to twenty.

In American naval practice the rotative speed with reciprocating engines is not ordinarily allowed to exceed 500 revolutions per minute, while the diameter of the wheel ranges from 4 to 6 feet, except in the smaller vessels. As a rule, fans for closed fire-room service are operated at such peripheral speed as to maintain a pressure of about 4 inches of water over their capacity area. This pressure corresponds to a velocity of 7,825 feet per minute, which, with a wheel of 5½ feet diameter, would demand about 450 revolutions per minute. If called upon to deliver 30,000 cubic feet per minute through its capacity area, such a fan would require to be 2 feet in width at the rim. The relations existing between the volume discharged, the pressure created and the power required at a given speed are forcibly illustrated by the curves in Fig. 4.

Commercially, fans are classified as blowers and exhausters. The former type has an inlet upon either side, and cannot be readily applied for exhausting through connecting pipes.

The exhauster, which has an inlet upon one side only, is, however, so designed as to permit of free connection thereto. The fan is overhung upon the shaft, while the pulley or driving motor and both bearings are placed upon the closed side of the fan. Under this technical designation, the so-called forced draft "blower" is usually an exhauster, designed to draw its air from the atmosphere or from other parts of the ship through a single inlet.

A further rough classification may be made into volume and pressure fans. The former class particularly includes all fans designed for purposes of ventilation, mechanical draft and the like, in which quantity of air is the first desideratum.

Athough about 12 pounds of air is chemically required for the combustion of an average pound of coal, this amount

serves only when every individual atom of oxygen comes in contact and unites with corresponding atoms of hydrogen or carbon. The arrangement of the fuel upon the bed, and other circumstances, render this result impossible under working conditions. It therefore becomes necessary to supply the air in such excess as to make good any local deficiencies. Although, in actual practice, the air supply ranges

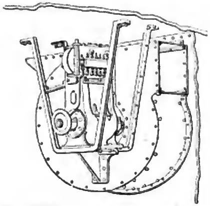


FIG. 3.—TYPICAL FAN WITH DOUBLE-CYLINDER ENGINE.

all the way from 50 to over 300 percent in excess of that theoretically required, it may be generally accepted that under good conditions of natural draft the volume is seldom less than twice that chemically required, though with mechanical draft it is possible to materially reduce this amount. Twenty-four pounds of air is equivalent to about 300 cubic feet at 60 degrees. Analysis of the gases escaping from the watertube boilers of the United States cruiser *Cincinnati*

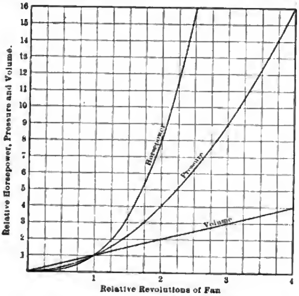


FIG. 4.—THEORETICAL RELATIONS INVOLVED IN OPERATION.

showed, for instance, an average of 19.6 pounds of dry gas per pound of carbon.

In boiler practice the force of the draft must be expended in two ways:

First, a portion is necessary to overcome the resistances of the grate and the fuel upon it, of the combustion chamber, flues or tubes and uptake, and of the means of connection to the source of draft, be it fan or stack. The sum of these resistances is a measure of the *pressure head*.

Second, the draft must, in addition, be sufficient to impart to the air the velocity necessary to furnish the amount requisite for the direct purpose of combustion. This is a measure of the *velocity head*.

With a constant total head, any change in the resistances immediately alters the relation between the pressure and the velocity heads. Thus, for instance, a thicker fire or finer coal increases the resistances and reduces that portion of the draft available for the production of velocity. As a result, the air supply becomes inadequate and greater total intensity of draft is necessary to maintain the original combustion rate.

A careful study of boiler resistance is necessary to a thorough consideration of the practical conditions of draft production. Prof. Gale found, in the case of a stationary boiler furnace of ordinary construction, the various pressures, expressed in pounds per square foot, in Table II.

TABLE II.—PRESSURE CONDITIONS IN STATIONARY BOILER FURNACE.

Required to produce entrance velocity (3.6 feet per second)	0.013
Required to overcome resistance of fire grate	0.91
Required to overcome resistances of combustion chamber and boiler tubes	1.23
Required to overcome resistance in horizontal flue	0.06
Required to produce discharge velocity (11.2 feet per second)	0.085
Total effective draft pressure	2.298
Back pressure due to friction in stack	0.19
Total static pressure produced by chimney	2.488

The total static pressure, which is given in pounds per square foot, is equivalent to 0.28 ounce per square inch, or 0.48 inch of water. From these results it is evident that only about 4 percent of the total draft pressure was actually expended for the production of velocity and the movement of air. Designs for draft-producing apparatus are not, therefore, to be based solely upon the volumetric requirements. If this were the case, a low stack or a large slow-running fan would meet the conditions. In reality, the design must first contemplate the creation of sufficient intensity of draft and then provide capacity for the necessary amount of air.

In the case of a chimney, the maximum draft, being dependent upon its height, is constant for the same temperature, and regulation of the combustion can be secured only by throttling the air supply. With a fan, however, the intensity of the draft may be instantly changed from zero to the maximum, with a proportional increase in the air volume. It must already be evident that only under the latter condition can the requirements of combustion most readily be met, for it is manifest that in order to maintain constant steam pressure with varying fuel conditions there must be comparatively great and rapid changes in the draft.

The chimney as a means of creating movement of air depends upon the heating of that air, by which a difference in density is produced. The heat thus employed is, however, absolutely wasted so far as its utilization for other purposes is concerned. Any attempt to extract more of the heat from the gases as they escape from the boiler must with a given chimney result in a reduction of the draft. The loss under various conditions is made evident in Fig. 5. This inherent loss actually amounts to about 20 percent with ordinary coal, when the gases are at 500 degrees and the excess of the air is 100 percent. Reduction in the loss of heat in the escaping gases may be secured by decreasing the volume of air supplied in excess of that chemically required, and by providing means for the abstraction of heat from the gases after they leave the boiler.

The loss resulting from the supply of air in excess of that necessary for perfect combustion is twofold in its character:

First, the excess of air entering the furnace is heated by

the burning fuel, thereby lowering the temperature of the mixture of gases and air below that which would prevail if the gases only were present. As a consequence, the rate of absorption of heat by the water is reduced, for it is dependent upon the difference in temperature between the water and the gases.

Second, owing to larger volume and higher velocity, there is less time to part with the heat. As a consequence, the temperature of the mixture of gases and air escaping to the chimney is higher than would be the case if there were no excess of air; while the increased volume is such that the total amount of heat thus carried away, without exerting any useful effect, is greatly increased. In other words, paradoxical as it may seem, the larger the volume of air supplied the higher will be the temperature of the escaping gases, within the ordinary range of boiler practice.

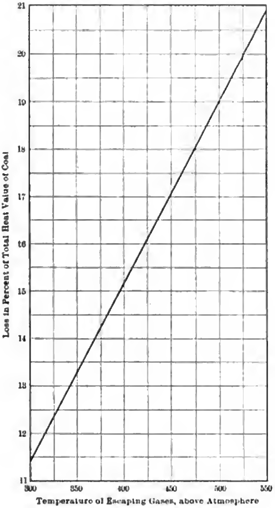


Fig. 5.—Loss of Efficiency Due to Temperature of Escaping Gases Above Atmosphere, with 100 Percent Excess Air.

Table III.—Relation of Draft and Rate of Combustion.

Pounds of Dry Coal burned per Hour per Square Foot of Grate.	Furnace Draft	Resistance, in Inches of Water, Due to			Total Draft in Inches of Water.			
		Pass under Boiler & through Tubes.	Retarders in Tubes	Pass over top of Boiler	No Return Pass: No Retarders.	No Return Pass: With Retarders	With Top Pass: No Retarders.	With Top Pass: With Retarders.
5	0.04	0.04	0.00	0.04	0.08	0.08	0.12	0.12
10	0.13	0.07	0.03	0.05	0.20	0.23	0.25	0.28
15	0.20	0.11	0.03	0.05	0.31	0.34	0.36	0.39
20	0.24	0.16	0.08	0.06	0.40	0.48	0.46	0.54
25	0.27	0.22	0.19	0.06	0.49	0.68	0.55	0.74
30	0.30	0.27	0.31	0.07	0.57	0.88	0.64	0.95
40	0.36	0.38	0.46	0.08	0.74	1.20	0.82	1.28

Intimate distribution of the air through the fuel is manifestly essential to perfect combustion. For such intimacy of contact intense draft and a clean and reasonably thick fire are necessary; conditions which may be most readily maintained by means of mechanical draft. The relation of draft to the rate of combustion in a horizontal return tubular boiler, with or without retarders in the tubes, is indicated by Table III.

With a thick fire, the air is compelled to come in contact with a greater amount of fuel, and is afforded a better opportunity to promote perfect combustion. This points to the supply of decreased volumes of air with higher rates of combustion. Table IV. shows results secured by J. M. Whitham in tests with a Wilkinson stoker in stationary practice.

Table IV.—Air Supply with Different Rates of Combustion on a Wilkinson Automatic Mechanical Stoker.

Buckwheat Coal burned per hour per Square Foot of Stoker Grate. Pounds.	Air to burn One Pound of Buckwheat Coal.		Percentage of Excess or Deficiency of Air Supplied.
	Theoretically Req'rd Cubic Feet.	Actually Supplied Cubic Feet.	
12.0	125	232	+ 85.6
18.0	125	157	+ 25.6
25.2	125	132	+ 5.6
32.5	125	123	— 1.6
41.5	125	111	— 11.2
45.4	125	111	— 11.2

Tests upon a marine boiler have shown that with a constant combustion rate of 27 pounds the water evaporated per pound of coal from 212° increased from 10.77 pounds with a 9-inch fire, to 11.54 pounds with a 14-inch fire.

(To be concluded.)

Another Brazilian Liner.

We present photographs of the steamship *Para*, a Brazilian liner built by Workman, Clark & Company, Limited, Belfast, one of nine vessels of various types to be built by them for the Lloyd Brazileiro of Rio de Janeiro, and a sister ship of the *Ceará*, described at page 404 of our October, 1907, number. The *Para* is 354 feet in length, with a gross tonnage of over 3,500 tons, and has been built to the highest class in Lloyd's Register, besides fulfilling all the requirements of the British Board of Trade for foreign-going passenger steamers. In general design and arrangements, the vessel has also been made to conform to the requirements of the passenger and general cargo trade of the South American coast.

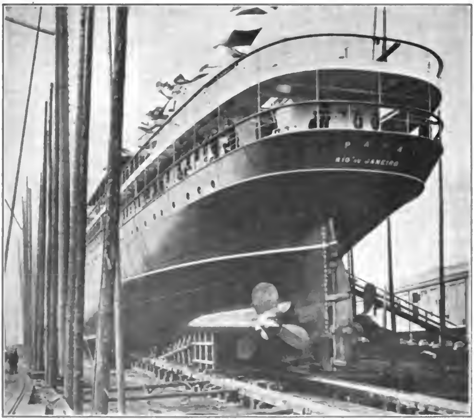
Each of four holds, into which the cargo space is divided by watertight bulkheads, is provided with hatchways, equipped with powerful hydraulic cranes, capable of rapidly loading and discharging cargo. Baggage and parcel rooms are provided for the stowage of passengers' luggage and mail, and bullion rooms are also fitted up.

The propelling machinery and boilers were constructed by Workman, Clark & Company, and consist of two sets of triple expansion engines, with all the most recent improvements, and three steel cylindrical multitubular boilers, working under Howden's system of forced draft. Steam for the auxiliary engines and deck machinery is supplied by an auxiliary boiler.

Accommodation is provided for 170 first class passengers, 20 second class and 300 third class. The rooms for the first class passengers are on the upper and main decks, and in addition to the ordinary staterooms, a number of *cabins de luxe*

THE BRAZILIAN STEAMER PARA ON TRIAL TRIP.

are provided; these suites consist of a sitting room, bed room, bath room and lavatory. The first class dining saloon, on the main deck, is a large, roomy and well lighted apartment extending the full width of the vessel. From this saloon a wide staircase leads to the main entrance hall on the upper deck, which is fitted up as a lounge. Opening off it are the *cabins de luxe* and principal staterooms; and a broad central corridor runs fore and aft, with staterooms opening off on each side. Large double doors on each side of this entrance hall open on to the deck. The main staircase continues from this deck to the entrance hall on the shade deck. The forward end of this hall opens into the music saloon, and at the



THE STERN OF THE PARA JUST PREVIOUS TO LAUNCHING, SHOWING THE WEB STRUTS.

THE SHIP AFLOAT AFTER LAUNCHING, AND READY FOR RECEIVING MACHINERY AND FITTINGS.

after end is the smoking room. Both of these rooms are lofty and well lighted apartments, handsomely furnished. Double doors on each side of the entrance open on to the shade deck, which affords ample promenading space. On this deck are additional first class staterooms, and the officers' rooms have been placed in a deck house at the forward end of the funnel casing, below and abaft the pilot house.

THE BOW OF THE PARA SHOWS GRACEFUL LINES AND A GENEROUS FREEBOARD.

The second class accommodation is arranged on the main deck forward of the boiler room, and includes a large central dining saloon, with staterooms opening off alleyways on each side of the saloon. The steerage quarters are at the forward end of the main deck, and include a separate apartment for women. The remainder of the space is fitted up with iron beds and hammocks.

THE BRAZILIAN STEAMER PARA TAKING THE WATER AT THE YARD OF WORKMAN, CLARK & COMPANY, LIMITED.

The engineers' and petty officers' rooms are in the 'midship house on the upper deck, and the top-gallant fore-castle is arranged for the accommodation of the crew. An efficient system of natural and artificial ventilation is arranged throughout all the living and public rooms, and the sanitary arrangements have received special attention. The galleys and pantries are supplied with all modern appliances. The auxiliary machinery includes patent fire-extinguishing apparatus, also Welin quadrant davits. Benjamin Taylor.

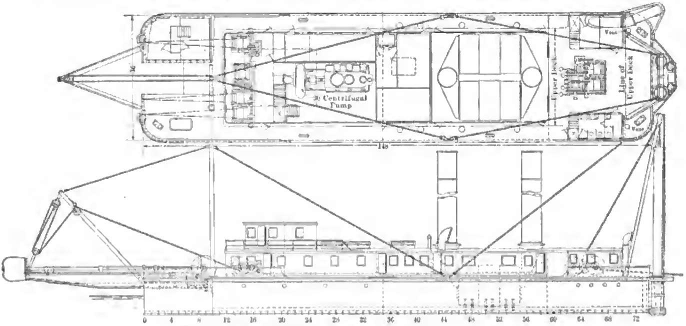
A Large Hydraulic Dredge.

The dredge *Francis T. Simmons* is a large and powerful machine built to the order of the commissioners of Lincoln Park, Chicago, for the purpose of filling in the new park extension to the north of the present park. The plan is to reclaim from Lake Michigan an area approximately 1,500 feet wide by about a mile long, by inclosing it with a stone revetment or breakwater, and filling in behind this with material taken from the bed of the lake. For much of the distance the breakwater lies in 18 feet of water, and the total volume of fill is about 4,000,000 cubic yards. The breakwater is now partly completed and is made of stone from the spoil-banks of the Chicago drainage canal. A fleet of large scows and several powerful tugs are employed to bring the stone from the canal by way of the Chicago river, out into the lake, and so to the site of the work.

The conditions surrounding the dredging and filling of this work were difficult and peculiar. Not only was the locality in deep water and exposed to the storms of Lake Michigan, which often rise with suddenness and severity, but the soil to be dredged consisted of the tough blue clay which underlies the Chicago area, compacted by the storms of the lake, and mixed with more or less gravel and stones. The ordinary hydraulic dredge as used on the lakes would therefore be unsuitable, both because of unseaworthiness and because it could deal effectively only with soft material. The usual floating pipe-line connected by rubber sleeves and mounted on a number of small scows or floats would be put out of business with every wind storm, or irretrievably wrecked.

The superior economy of the hydraulic process of dredging and filling, if it could be successfully applied, led the commissioners to apply to A. W. Robinson, A. S. C. E., of Montreal, who had previously designed and built several large hydraulic dredges, notably the *Tarte*, which is employed in dredging clay from the bed of Lake St. Peter, in the River St. Lawrence, and which is provided with a special pipe line for withstanding heavy storms. This dredge is of great power, and holds the world's record for output, having dredged 750,000 cubic yards in a calendar month and delivered it at a distance of 2,000 feet. The original pipe line of this dredge is still in use, after having withstood the storms of five years.

It was, of course, realized that Lake Michigan in its angry moods would be too rough to attempt continuous dredging operations, and that the most that could be done would be to provide a plant of large capacity, so that the required output could be made after making allowances for weather interruptions, and also seaworthy enough to increase the working time to the largest possible amount. It should also be designed for safe and rapid picking up of anchorages and pipe line in case of storm, and to safely withstand any stress of weather when not working.



ELEVATION AND GENERAL DECK PLAN OF HYDRAULIC DREDGE FRANCIS T. SIMMONS.

To meet these conditions Mr. Robinson designed the present dredge, which was built by the Atlantic Equipment Company, 111 Broadway, New York, and put in service in June, 1907.

The hull is of steel, 148 feet long, 38 feet wide and 10 feet 6 inches deep. The frame spacing is 24 inches. The main pump has 30-inch suction and discharge, and the main engines are of the triple expansion marine type, of 1,200 indicated horsepower, built by the Neafie & Levy Ship & Engine Building Company, Philadelphia. This engine has cylinders 17, 27 and 44 inches in diameter, with a stroke of 24 inches. There are two double-ended marine boilers, built by the Manitowoc (Wis.) Dry-Dock Company, 11 feet 6 inches diameter by 18 feet long, with eight corrugated furnaces. The installation of engine room auxiliaries, such as condensing apparatus, pumps, electric lights, etc., is most complete and well arranged, the engine-room space, in fact, resembling that of a small ocean liner.

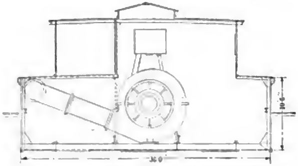
On the upper deck is a pilot house with large plate glass windows, where are arranged all the levers which control the

THE HYDRAULIC DREDGE FRANCIS T. SIMMONS AT WORK IN LAKE MICHIGAN.

operation of the dredge. Here are also pressure and vacuum gages for all purposes, indicating exactly the work that is being done.

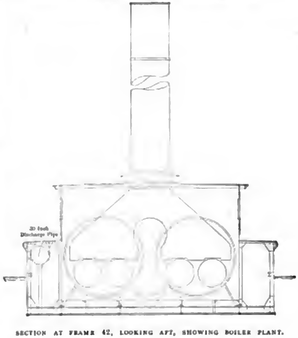
The suction pipe is carried by a very strong steel frame, and is fitted with a powerful cutter for digging the clay. This cutter is an improved development of a number of earlier machines, and has demonstrated its efficiency by being able to handle the heaviest clay up to the full capacity of the pump. It is 9 feet in diameter, and weighs about nine tons, being formed of eight steel blades of peculiar curvature cast in one piece, and having renewable hard steel cutting edges attached. The mechanism for driving and feeding this cutter is of the most powerful description. The secret of success of this dredge is that the excavation of the stiff clay is done by an efficient cutting tool that will not clog, and provided with a powerful feed, the main pump being employed only for transportation of the spoil. A capacity rate of 3,000 cubic yards per hour has frequently been reached in clay, the entire under side of the discharge appearing as continuous slices of blue clay, some of the pieces being four or five feet long.

One of the most serious problems to be dealt with was that of the floating pipe line. This is the most seaworthy pipe line on the lakes, and is formed of semi-submerged steel pontoons about 100 feet long, connected by ball-and-socket joints, having spring connections of great strength. Long lengths of pontoon were necessary to give steadiness in waves, and a yielding connection was essential to relieve the joints of the great stresses due to surging. The springs are of locomotive draw-bar size, and are arranged similarly to



SECTION AT FRAME 20, LOOKING AFT, SHOWING CENTRIFUGAL PUMP.

THE PONTOONS AND PIPE-LINE SUPPORTS.



SECTION AT FRAME 42, LOOKING AFT, SHOWING BOILER PLANT.

railway car draft rigging. There are also tension and compression springs to control the side deflection of the joint. In wave action this pipe line is very satisfactory. A special flange connection is provided at the dredge, so that the pipe line can be instantaneously disconnected from the dredge at any time, simply by pulling out a toggle lever. On several occasions, when it became too rough for the dredge to work, owing to the difficulty of discharging over the breakwater, the pipe line was disconnected and towed to harbor by a tug, through a rough sea which broke over both tug and pipes continuously, with no harm whatever to the pipe line. These occasions, however, are relatively rare, and the operation of the dredge has proved not only that the clay of the bed of Lake Michigan can be dredged by this method, but also that the seaworthiness of both dredge and pipe line is sufficient to reduce the delays on account of weather to a comparatively small amount.

The cost of the dredge was $148,000 (£30,412). When at work, it is held in position by two spuds, 45 feet long, with steel tips weighing 12 tons each. The dredge is not self-propelling.

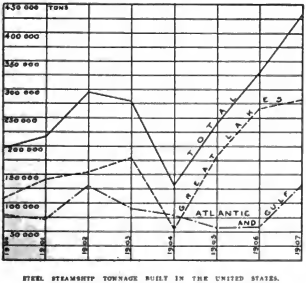
Shipbuilding in the United States.

The Bureau of Navigation of the Department of Commerce and Labor reports the construction in the United States during the calendar year 1907 of 1,056 merchant vessels aggregating 502,508 gross tons, as compared with 1,045 vessels of 393,291 tons in 1906, and 1,054 vessels of 306,563 tons in 1905. The

MERCHANT VESSELS BUILT IN THE UNITED STATES.

Year.	Ships.	Gross Tons	Average Tons.	Great Lakes Ships. Gross Tons.	Per cent.	Average
1900......	1,102	365,791	332	129,973	35 6	1,476
1901......	1,322	376,129	284	156,157	41.5	1,270
1902......	1,270	434,005	342	158,230	36 5	1,521
1903......	1,159	381,970	330	182,593	47.8	1,438
1904......	1,063	265,104	249	54,042	20 4	819
1905......	1,054	306,563	291	182,361	59 5	1,736
1906......	1,045	393,291	376	268,085	68 2	2,197
1907......	1,056	502,508	476	283,492	56 4	2,100

gain is very marked, being about 28 percent. This tonnage is greater than that of any year since 1855, which showed 583,450 tons. The only other year in the history of American shipbuilding when the figure exceeded 500,000 tons was in 1854, with 536,046. In both these cases more than 83 percent of the tonnage was in sailing vessels, whereas of the present year's figures the sailing tonnage amounts to only 29,324, or 5.8 percent.



STEEL STEAMSHIP TONNAGE BUILT IN THE UNITED STATES.

Of the total for the year, not less than 135 vessels of 283,492 tons are accounted for by the Great Lakes. This represents 56.4 percent of the total tonnage, which is a falling off in percentage as compared with the two previous years, although the total lake tonnage has increased. The healthy increase of 93,810 tons (from 125,206 to 219,016 tons) on the coasts is very encouraging, consisting, as most of it does, in steel steamers (gain 88,627 tons, from 61,528 to 150,155 tons). The tables and diagram give the results since the beginning of 1900.

STEEL STEAMERS BUILT IN THE UNITED STATES.

Six Months Ending.	Totals. Ships.	Totals. Gross Tons.	Atlantic and Gulf Ships.	Atlantic and Gulf Gross Tons.	Great Lakes. Ships.	Great Lakes. Gross Tons.
June 30, 1900...	52	105,713	31	34,803	17	63,885
Dec. 31, 1900...	40	91,244	20	44,179	16	44,626
June 30, 1901...	64	144,021	31	46,297	30	91,994
Dec. 31, 1901...	40	74,604	21	25,541	17	49,020
June 30, 1902...	74	196,197	34	76,186	32	109,019
Dec. 31, 1902...	42	96,516	26	52,385	12	43,248
June 30, 1903...	69	153,389	33	54,411	29	88,412
Dec. 31, 1903...	50	126,392	20	36,077	28	89,562
June 30, 1904...	43	113,261	27	61,904	13	50,336
Dec. 31, 1904...	31	19,472	25	16,955	5	2,496
June 30, 1905...	42	139,883	17	39,822	24	99,999
Dec. 31, 1905...	51	100,127	27	18,843	21	80,932
June 30, 1906...	58	181,614	25	24,378	31	156,792
Dec. 31, 1906...	56	146,177	33	35,895	21	109,471
June 30, 1907...	66	214,488	38	75,564	26	129,242
Dec. 31, 1907...	69	216,181	34	53,167	31	161,272

New Steamship Lines.

The Archaia Steamship Company and the Austro-Americana Steamship Company have made an arrangement whereby the former will operate steamers from Smyrna and neighboring ports in the Grecian Archipelago to Patras, in time to catch steamers of the latter line sailing from Patras via Trieste every ten days to New York and New Orleans alternately. All of the vessels are fitted for handling both passengers and cargo. The sailing time from Patras to New York is about fourteen days, and to New Orleans about the same. This latter port is a new departure for steamship companies trading with the levant.

Two lines which recently began operation between Rotterdam and New York, carrying freight and steerage passengers, are the Russian Volunteer Fleet, with an aggregate of 26,774 tons in four vessels, and the Russian East Asiatic Steamship Company, with four vessels, amounting to 19,283 tons. The largest vessel in each fleet can carry about 1,300 passengers. All sail under the Russian flag, and have headquarters at Libau. The service is fortnightly in each case.

A new service is being started between New York and the east coast of South America by the Lamport & Holt Line, sailing under the British flag. Steamers are to be sent out semi-monthly, the first of the new class being the *Verdi*, leaving New York January 20, 1908. The ships will run to the Plata in about twenty-one days, including stops at Bahia, Rio de Janeiro and Santos. Owing to difficulty in obtaining satisfactory coal in South America, these vessels have to carry enough from New York (3,100 tons) to make the round trip.

A new line is to be started in the near future between Trieste, Austria, and Charleston, S. C. Regular service is to be established for the carrying of both freight and passengers.

The Compagnie Générale Transatlantique is about to divert from New York to Montreal some of the older of the ships now visiting the former port. This will make regular service from Havre, and will be in direct competition with some of the Allan Line steamers.

INTERNATIONAL MARINE ENGINEERING

Published Monthly at

17 Battery Place New York

By MARINE ENGINEERING, INCORPORATED

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President

E. L. SUMNER, Secretary

and at

Christopher St., Finsbury Square, London, E. C.

E. J. P. BENN, Director and Publisher

SIDNEY GRAVES KOON, Editor

Branch Offices { Philadelphia, Machinery Dept., The Bourse, S. W. ANNESS. Boston, 170 Summer St., S. I. CARPENTER.

Entered at New York Post Office as second-class matter.

The edition of this issue comprises 6,000 copies. We have no free list and accept no return copies.

Shipbuilding in the United States.

The tables and diagram in another column show a very decided increase for the year 1907, as compared with previous years, in American shipbuilding. It frequently happens that when such an increase is noted, for any one year over a previous year or series of years, the gain is found to lie almost wholly in the shipbuilding on the Great Lakes. This time, however, a change has occurred, for the gain on the Great Lakes is only a small percentage of the total gain for the year. It happens that there have been a considerable number of large coastwise steamers built during the past year, and a few for off-shore trips, such as those to Hawaii and Cuba. Many of these vessels have exceeded 4,000 tons in measurement, and the result has been a very great increase, as compared with the previous year, in the construction of steel steamers for salt water use. As shown in another column, this last mentioned increase, from 61,528 to 150,155 tons, represents a gain of 88,627 tons, or not less than 144 percent.

If there were orders or inquiries in hand which might give rise to a reasonable expectation that this state of things would continue, the situation would be decidedly encouraging. Unfortunately, however, the boom, if such it might be termed, appears to have been wholly of a temporary character, and it is more than likely that the year 1908 will show a very decided falling off as compared with 1907, even though it may possibly exceed the figures for 1906 and for the previous years. American ship owners and shipbuilders are looking earnestly to Congress for some action which would place the United States merchant fleet upon some sort of a parity with the merchant fleets of many of the other countries, particularly in the way of postal subsidies. If such action is taken, it is practically certain to result in a decided increase in the number of vessels built, and it is practically certain that some of these would be for foreign service, particularly between the United States and some of the South American countries.

This is a proposition which has frequently come up for consideration, and a year ago such a bill was actually passed by both Houses, but the Representatives made such radical alterations in the original Senate bill that when it got back to the Senate for confirmation, it was "talked to death." The measure has many powerful enemies, and many friends. The main features comprise mail subsidies to lines of regular steamers to various South American ports, with certain conditions as to speeds, extent of service, and other points; and, of course, all must fly the American flag and be built in the United States. It is confidently expected that the passage of some such bill would act as a substantial stimulant to the shipbuilding industry—and particularly the most important part of it—that concerned with the construction of large ships. An argument of considerable potency was found in the recently developed inability of the American merchant marine to provide a sufficient number of suitable ships to act as colliers for the battleship squadron, now *en route* to the Pacific coast.

The New York Motor Boat Show.

The show which was held in the Grand Central Palace from Dec. 7 to Dec. 14, 1907, was notable in many respects. The great variety of the exhibits and their general quality of interest drew a very large crowd to the afternoon and evening sessions, while the demonstrations in the morning and afternoon gave food for much thought to those who attended the show for the serious purpose of looking into the subject from the point of view of prospective purchasers.

Particularly prominent were the smaller types of boats, with engines of from 1 to 10 horsepower, and speeds from 5 to 8 miles per hour. The prices marked on boats of this character were, in many cases, surprisingly low, due largely to their being turned out to

identical patterns in considerable numbers—manufactured, in other words—and to the fact that standardization, particularly in the engine department, has brought about a very substantial reduction in the cost of manufacture during the last two or three years. Boats of this type carry engines of very staunch build—quite different from the light, and in many cases rickety, engines carried by the modern automobile. As a result, the motor-boat engines can be depended upon to operate hour after hour with very little care or adjustment, as compared with which many of their sister type are continually getting out of order. The staunch construction carries with it, of course, a considerable increase in weight, but this is one of the many features which has helped to reduce the cost of production, inasmuch as the extremely light motors of the other type require the utmost refinement in design, material and workmanship, and in many cases an extremely low value for the factor of safety.

There were not present this year so many boats of the very large and expensive type as were exhibited a year ago, but those that were there were of a healthy, substantial design, some of them being intended for work in rough water at a moderate speed, and others for high-speed operation on rivers, lakes and such inclosed bodies of water as Long Island Sound. The main object of all of these designs seems to have been the provision of maximum comfort in minimum space, there having been only one boat exhibited which was greater than 35 feet in length.

Aside from the boats, there were scores of engines of all sizes and types, from the smallest up to as much as 75 or 100 horsepower, and a great variety of what might be termed auxiliary appliances, such as small dynamos for lighting, or other electrical purposes, devices for measuring speed, searchlights, propellers of both the solid and the reversing type, reversing gears, and the innumerable odds and ends that go to make up the sum total of the outfit of a modern motor boat.

Modern Marine Transportation.

The article under the above heading, which we are concluding this month, brings up a subject which in many of its component parts has been under contemplation by various engineers for some time. The entire assemblage, however, of these parts into one harmonious whole, and their development into working shape, is a new departure, and is one which bids fair to have a considerable future ahead of it. The whole thing is delightfully simple from the point of view of operation, and very much can be said in its favor. It has not, however, as yet had a practical demonstration, and, until that comes, we cannot say with much certainty just what the ultimate outcome is to be.

The proposition to keep the power part of the equipment almost continuously in operation is thoroughly sane, it being a well recognized fact that under present conditions very many steamers are stationary considerably more than one-half of their time, even though they may be considered as busy vessels, and may be continually supplied with work. By laying up, however, for loading and unloading, only that part of the equipment comprised by boats carrying cargo, but not carrying the main prime movers of propulsion, we are getting full returns from the power plant, and a consequently much reduced interest and stand-by charge per unit of work performed.

The financial statement worked out in the present number has been based entirely upon conditions as they exist to-day along the north Atlantic coast of the United States. The figures have been obtained from thoroughly competent and reliable sources, and we are informed that they may be depended upon with entire certainty. The saving of the electric unit system as compared with the ordinary system, in which a single steamer is used to perform the entire work now proposed for a fleet of barges, is very marked. Of course the figures do not in any sense represent the profits which might be expected in either case from the operation of either the steamer or the fleet. They do, however, represent relative figures in a sufficiently exact way to render such a comparison of considerable value in connection with the formation of a program for carrying into effect the provision of such a fleet for the purposes outlined.

The alternative suggestions made for the use of part of the power are interesting, involving, as they do, under certain conditions, the provision of refrigeration, electric lighting, electric hoisting and various other functions, all from the one main source of energy located in the power boat. The use in these cases of absolutely standard equipment, such as can be purchased at any time in the open market, would make it perfectly easy, when one vessel happened to be tied up to shore for the purpose of discharging or taking on cargo, or for any other purpose, to make proper electric connections, and thus continue all these functions without more than momentary cessation while the connections are being made. In this way transportation of perishable fruit products, necessitating the use of mechanical refrigeration, could be carried out with perfect safety to the cargo, and with a reasonable expectation that it would be found upon delivery to be in good shape.

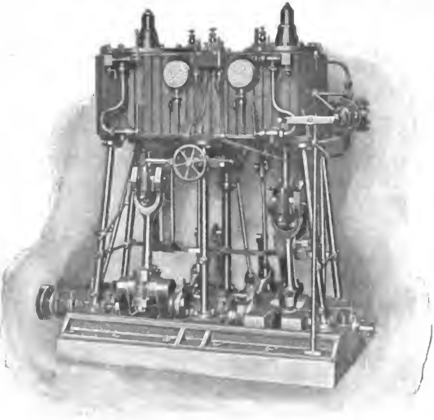
The whole proposition is one which certainly merits a practical investigation and demonstration of its capabilities, and it is to be hoped that some enterprising manager of a transportation line will see fit in the not distant future to give it a thorough trial. It is a system which, once started, would readily lend itself to indefinite expansion, and hence, if it should prove even half as successful as its promoter expects, there should be a steady increase, after once the entering wedge made itself manifest as a dividend earner.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports, Dec. 10, 1907, the following percentage of completion of vessels for the United States Navy:

	Tons.	Knots.		Nov. 1	Dec. 1.
BATTLESHIPS.					
Mississippi	13,000	17	Wm. Cramp & Sons	96.82	98.01
Idaho	13,000	17	Wm. Cramp & Sons	89.41	91.24
New Hampshire	16,000	18	New York Shipbuilding Co.	90.2	93.1
South Carolina	16,000	18½	Wm. Cramp & Sons	28.83	31.68
Michigan	16,000	18½	New York Shipbuilding Co.	29.1	33.5
Delaware	20,000	21	Newport News S.B. & D.D.Co	2.33	5.08
North Dakota	20,000	21	Fore River Shipbuilding Co.	4.23	7.84
ARMORED CRUISERS					
North Carolina	14,500	22	Newport News Co.	93.33	95.17
Montana	14,500	22	Newport News Co.	87.38	89.49
SCOUT CRUISERS.					
Chester	3,750	24	Bath Iron Works	92.7	94.
Birmingham	3,750	24	Fore River Shipbuilding Co.	90.79	91.88
Salem	3,750	24	Fore River Shipbuilding Co.	88.52	90.29
SUBMARINE TORPEDO BOATS.					
Cuttlefish	—	—	Fore River Shipbuilding Co.	99.	99.

ENGINEERING SPECIALTIES.



Small Steam Yacht Engines.

Messrs. W. Sisson & Co., Ltd., Gloucester, have confined themselves chiefly to high speed, high class machinery for yachts, launches, tug boats, passenger and small cargo vessels, and also make a specialty of small side and stern paddle wheel machinery.

The illustration shows a compound non-condensing engine of 280 indicated horsepower, fitted in the Windermere launch *Elfin*, and giving her a speed of 24½ statute miles per hour. This engine is supplied with steam from a loco-marine type boiler, at 190 pounds working pressure. The valve gear is of their specially designed single fixed eccentric or "elliptic" type, all the working joints being made adjustable. This type of valve gear is said to be much superior to the ordinary link motion, there being no sliding working parts, but pin joints, which are easily adjustable for wear. Ample surface is provided throughout, and as it is a very easy working gear, it will run a long time continuously without needing adjustment. It is also said to give a better steam distribution than the link motion, and is very easily handled.

"Agrippa" Fittings Wrench.

A drop-forged wrench for use on pipe fittings, which gets into the tight, narrow places and bites on irregular surfaces where a broader chain wrench would fail, is being placed on the market by J. H. Williams & Company, 150 Hamilton avenue, Brooklyn, N. Y. It is claimed that this wrench greatly reduces the trouble and annoyance which is always occasioned when handling short nipples and flange connections, or jobs with a variety of outlets. The wrench has a narrow, powerful jaw for both pipe and fittings. The "Agrippa" wrench is the outcome of the Vulcan chain pipe wrench, which has stood the test of many years' service.

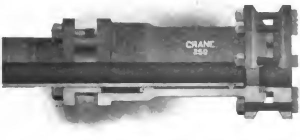
This wrench is made of all wrought steel with drop-forged jaw given a soft temper, and permanently fastened in a milled pocket to a solid, forged-steel handle. The chain is longer than in wrenches made for pipe only, so that it may easily take in large fittings, and is hand made so that there is no danger of flaws. This chain swings from the center, and can be used on either side of the jaw.

A New Expansion Joint for Ammonia.

The practice of providing for expansion and contraction in ammonia work is increasing, particularly on long lines. A

device for this purpose which is well adapted for marine work, on account of its compactness, is the expansion joint which has recently been placed on the market by the Crane Company, Chicago.

This device consists of a semi-steel body, with a sleeve made of extra heavy wrought pipe. To prevent the joint from pulling apart the sleeve is recessed near the end, and a split ring

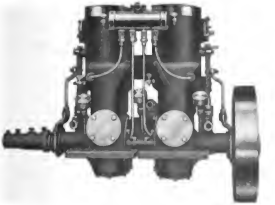


inserted. Should the line give way, this ring cushions against the bushing in the bottom of the stuffing box, thereby holding the sleeve in place. As the gland studs are made very heavy, this construction accomplishes the same purpose as tierods, with considerable saving in space.

The sleeve is threaded to make an ordinary connection. The other connection is made by screwing the pipe into the body, which is recessed to take a square one-piece rubber gasket. The gasket is drawn up with a gland, forming a perfectly tight joint without the use of solder or litharge. The stuffing box is made with generous depth, so that repacking is necessary only at long intervals.

A Two-Cycle Motor.

The Mianus Motor Works, Mianus, Conn., has brought out a new model marine motor for 1908, made from new designs and patterns, but retaining all of the previous features. It is of the two-cycle, two-port, make-and-break type of ignition. One of the strong claims is for extreme good quality. Nickel steel forgings are used instead of ordinary carbon steel, tool steel parts instead of soft steel; cylinders, pistons, piston rings and other parts are ground to a perfect fit; in



fact material and workmanship are said to be fully equal to motors used on high grade automobiles.

To take care of a constantly increasing business, the builders have just completed a new machine shop, built entirely of concrete and steel. Power is supplied by a 60-horsepower gas producer. The new shop will enable them to more than double their present capacity.

TECHNICAL PUBLICATIONS.

Present Day Shipbuilding. By Thomas Walton. Size, 6¼ by 8¾ inches. Pages, 224. Figures, 163. 1907. Philadelphia: J. B. Lippincott Company. Price, $3.50 net. London: Charles Griffin & Company, Ltd.

This work, which is divided into four chapters, is based on Chapters III., IV., VI. and VII. of the author's "Steel Ships," the material having been revised, enlarged and especially arranged to form a complete manual in itself. The preface starts out with the remark that in general the appearance of the hulls of merchant steamers has not changed much in recent years, but that internally very decided improvements and numerous modifications have been made in ship construction. These have been largely in the way of getting rid of obstructions in the holds, such as beams, pillars and cumbersome stringers. It is with this new type of construction that the work particularly deals.

The first chapter is very brief, and is devoted to the classification of ships; the second chapter outlines the principal features and the alternative modes of ship construction; the third and fourth chapters, which are of about one hundred pages each, take up, respectively, types of vessels and details of construction. Under the heading of "types" we have discussions of one, two and three-deck ships; spar and awning deck vessels, and the various modifications of these types, with description and illustration of the principal structural features of many noted ships under these various headings. The details of construction take up the subject in a very comprehensive manner, with great numbers of sketches illustrating the various methods of connecting plates and forming certain portions of the ship's structure. The riveting, butts, frames, floors, beams, keelsons and stringers are given close attention, while the work goes then into miscellaneous details, rudders, masts, bilge keels, pumping devices, etc.

The great number of illustrations makes the work particularly valuable, and it is based on the very latest practice in its particular line. Among the illustrations might be mentioned an expansion of the outside shell plating of a large vessel, showing the arrangement of plates, butts, bulkheads and decks.

Sea Terms and Phrases: English-Spanish, Spanish-English. By Graham Hewlett, R. N. Size, 2¾ by 4 inches. Pages, 368. 1908. Philadelphia: J. B. Lippincott Company. Price, $1.25 net. London: Charles Griffin & Company, Ltd.

This is a pocket-sized glossary comprehending marine and general terms in Spanish and English, and is intended for the use of naval, army and merchant marine people who occasionally come into contact with Spanish-speaking nations. The vocabulary has been brought as nearly up to date as possible, but many old sea terms have been retained, as they are frequently found in Spanish literature, and are not well taken care of in the usual Spanish dictionaries. At the end of the work will be found papers of a Spanish merchant ship in Spanish, with corresponding translation into English on the opposite page. Following this is a tonnage certificate or a certificate of measurement, with corresponding translation; also a bill of health, and tables of relative ranks of officers in the Spanish and British navies and armies.

Marine Boiler Management and Construction. By C. E. Stromeyer. Size 6 by 9 inches. Pages, 404. Figures, 452. London and New York, 1907: Longmans, Green & Company. Price, 12s. net ($4.00 net).

This is the third edition of a work which was issued first in 1893. It deals entirely with the return tubular boiler, popularly known as the "Scotch" boiler, this type having stood the test of many years of operation. The main addition in this edition has been along the line of materials and better methods of

working them, due to a better knowledge of their structures and elements. This includes a study of the microscopic structures of various steels, and also a study of gas analysis and its relation to the up-take and funnel.

The work is divided into eleven chapters, the last two of which summarize the boiler rules of Lloyd's Register and the Board of Trade. The other chapters cover, respectively, boiler management, steam and water, corrosion, fuels and combustion, heat transmission, strength of materials, mechanics, boiler construction and design. The numerous illustrations are all in the nature of sketches, showing the various parts and the strains to which they are subjected, and the methods of achieving definite results from given material. The subject of riveting comes up for extensive treatment under the heading of "Boiler Construction." A comprehensive index at the rear of the volume makes it easy of reference.

Engine Room Chemistry. By Augustus H. Gill, Ph. D. Size, 4½ by 7 inches. Pages, 198. Figures, 47. New York and London, 1907: Hill Publishing Company. Price, $1 (4s.).

This little book is designed to place the simple chemistry of the engine room at the command of the progressive type of engineer who wishes to have all the ins and outs of his profession at his finger tips. The aim of the book is to enable the engineer to acquire such knowledge regarding the proper working of his plant as will enable him to save money for the employer, and to increase the efficiency of operation. It makes special point of the qualities of lubricants and of flue gases; also the quality of fuel and feed-water.

It is divided into seven chapters, and includes analyses of fuels, gas and lubricants, as well as a discussion upon boiler scale, pitting and corrosion, and upon the various physical and chemical properties of mineral, animal and vegetable oils. A good index renders it easy of access.

The Mechanical World Electrical Pocketbook for 1908. Size, 3¼ by 6 inches. Pages, 247. Figures, 50. Manchester: Emmott & Company, Ltd. Price, 6d net.

This is a new work of size fitted for the pocket, especially intended for those in charge of electrical plants and machinery, and for power users and others interested in the industrial application of electrical power. Attention has been particularly directed to the mechanical side of electrical engineering, with full discussions of such matters as belt and rope drive, worm gears, rawhide pinions and electrical cranes and pumping; but no attention has been paid to telegraphy, telephony or the details and refinements of electric traction and dynamo design.

The work starts out with a discussion of the various electrical units, going thence into dynamos and motors and methods of distributing electrical energy. Switches and the care of electrical machines and instruments are given considerable attention, particularly with regard to defects of dynamos and motors. A large number of tables will be found in the book, including wiring, power of dynamos, various mathematical tables, metric conversion factors, etc. Certain of the chapters take up the subject of galvanic and storage batteries, electric measuring instruments, lamps, and a very brief discussion of prime movers. At the end of the work is a diary for 1908. A complete index at the beginning adds much to the value.

List of Merchant Vessels of the United States, 1907. Size, 8½ by 9½ inches. Pages, 408. Washington, 1907: Government Printing Office.

This work is divided into five parts, including sailing vessels, steam vessels, unrigged vessels, loss of American vessels and government vessels. Under the latter heading is a list of the vessels of the United States Navy, giving the main particulars of dimensions, displacements, tonnage, speed and power; the vessels in the quartermasters' and engineer departments of the United States Army; the vessels of the revenue cutter service; of the lighthouse establishment; of the public health and marine hospital service; of the Coast and Geodetic Survey; of the Bureau of Fisheries, and of the Immigration Bureau.

The main part of the work is taken up with lists of all the merchant vessels of the United States, arranged in alphabetical order according to name. These three parts of the work show the official numbers, signal letters, rig, gross and net tonnage, length, beam and depth, crew, the date and place of construction and the home port.

Record of American and Foreign Shipping. Size, 8 by 9½ inches. Pages, 1,190. American Bureau of Shipping, 66 Beaver street, New York. Price, $15 (£3-1-4).

The volume for 1908, which is the fortieth annual issue of this register, is now being delivered to subscribers. The record contains full reports and particulars of 12,347 vessels, ranging from the ketch to the full powered transatlantic liner, and flying the flag of every nation, alphabetically arranged, with much detail as to build, ownership and condition. This information forms the bulk of the annual volume, but it also contains rules for the construction and classification of all classes of vessels, with illustrations and tables of great technical and practical value; revised rules for the construction of machinery and boilers, electric installations and refrigerating apparatus on shipboard.

The volume contains names of vessels which have been changed; list of compound names arranged alphabetically by last word of name for ready reference; list of addresses of prominent shipbuilders, drydocks and marine railways of the United States; list of owners of vessels; all of much value to the shipping interests. The work is approved and indorsed by the important boards of underwriters of the United States, and is accepted by the merchants and underwriters throughout the world as a standard classification of shipping. Supplements to the volume, issued semi-monthly, keep subscribers informed of new vessels constructed during the year, with reports of repairs to old vessels, and other useful information.

QUERIES AND ANSWERS.

Questions concerning marine engineering will be answered by the Editor in this column. Each communication must bear the name and address of the writer.

Q. 389.—(1) What is the heat value of wood alcohol in B. T. U.? Also of grain alcohol?

(2) What is the greatest velocity that can be imparted to water by steam at 150 pounds pressure by connecting several injectors in tandem? G. C. E.

A.—(1) The heating value of pure or absolute grain alcohol has been differently determined by various investigators, but the values range close about 12,000 B. T. U. per pound. A value 11,664 has been often used. These values must be reduced when the alcohol is not pure, to allow for the amount of water present. Thus we shall have approximately the following values:

Percentage of alcohol by volume.	Heating value per pound, B. T. U.
95	10,880
90	10,080
85	9,360
80	8,630
75	7,920
70	7,200

For pure methyl or wood alcohol the heating value per pound has been determined at about 9,500 B. T. U., or slightly more than three-quarters that of ethyl or grain alcohol.

It may be noted that the small proportion of wood alcohol used in denatured grain alcohol does not seriously affect the heating value of the latter as compared with the pure spirit, especially if certain other substances are added in small proportions, which may tend to counterbalance the loss of heating value due to the use of the wood spirit.

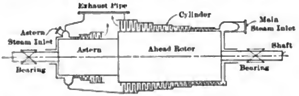
(2) The greatest velocity which can be imparted to water by steam at 150 pounds pressure will depend entirely on the relative proportions in which the steam and water are joined in the mixing chamber of the injector. Steam at this pressure would escape into the atmosphere at a velocity of some 2,800 feet per second. In the operation of an injector a very common proportion is about 12 pounds of water to 1 pound of steam. The combination will then have a velocity of about 215 feet per second. If more water is combined with the steam the velocity will be lower, and if less, it will be higher, up to a maximum of about 2,800 feet per second for a pure steam jet. In general, if x is the number of pounds of water handled by 1 pound of steam, then the velocity of the combination in feet per second will be about $2{,}800 \div (1 + x)$. W. F. D.

Q. 390.—A fore aod aft compound surface coodensiog marine engine, cyliodera 20 aod 40 inches with 26-inch stroke; boiler pressure 125 pounds and receiver pressure 10 pounds; low-pressure piston has no tail rod, and gives considerable trouble in knocking against cylinder wall in passiog top center. This occurs only when the boat is listed or in a seaway; the engine runs smoothly otherwise. The springs hold the piston steady only a short while, when they have to be reoewed. Is this doe to excessive weight of piston? Please inform me as to the proper construction, weight, etc., of a piston for soch service. J. W. P.

A.—It would probably take an examination of the engine to determine the cause of its giving trouble in connection with the low-pressure piston. From what you say, however, we are inclined to believe that the seat of the trouble lies in the connection between the piston and the piston rod. Unless the bearing in this case is of considerable length and very accurately adjusted you will be liable to have considerable trouble of the sort indicated. It is possible that there is some little play in this joint, which would make the piston bind during a certain part of the stroke.

Q. 391.—Will you explain with sketches the turbine system used on the Cunard liners *Mauretania* and *Lusitania*. I particularly desire iofarmatioo as to the manner in which the propeller is reversed. Is this done simply by transferring the steam from one end of the shaft to the other and allowiog it to escape? T. M. K.

A.—The propeller is reversed by simply transferring the steam from one end of the turbine cylinder to the other. To



go ahead, the steam is admitted to the forward end, and impinges on suitably arranged turbine vanes. The astern turbine is composed of vanes arranged in the opposite direction, and the steam is admitted at the after end of the cylinder, means being provided that steam cannot possibly be admitted to both ends at once. The steam passes direct to the condenser through a common exhaust pipe. When not working, the astern turbine revolves idly in a vacuum. The sketch shows the outline of this arrangement. E. M. S.

In actual operation, the steam from the throttle passes through a ring or girdle of stationary guide blades, by which it is directed upon a ring of blades or vanes mounted on the rotor at an angle, much like the blades of a wind-mill. The action of the steam gives this rotor an impetus. The steam then passes through a second set of guide blades, which direct it upon a second ring of rotor blades, to which it imparts a further impetus. In this way the steam traverses, in a sort of zigzag path, the length of the turbine.

SELECTED MARINE PATENTS.

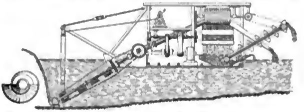
The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

868,774. DREDGING APPARATUS. THOMAS R. GOTH, SAN FRANCISCO, CAL.

Claim.—6. Io a dredger, a submerged or partially submerged pipe, and a rotary soail-shell shaped digger at the extremity of said pipe, said digger having a single cuttiog edge aod a single inlet opening in its periphery.

18. Io a dredger in which material is drawn and forced through aod beyond ao iotake pipe by the action of a hydraulic giant, means for



freeing the intake pipe, comprising a valve located beyood the giant aod adapted to close the discharge passage; whereby the stream from the giaot is forced backwardly through the intake pipe. Nineteen claims.

870,738. BOAT. CHARLES H. MYERS, BUFFALO, N. Y.

Claim.—2. In a boat, the combination with a body member having a bottom and a chamber depending below said bottom of a keel member secured to the body aod located below the bottom thereof, said keel

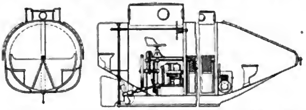
member having a pocket between its ends that receives the depending chamber, and being furthermore provided with air chambers located on opposite sides of the pocket. Eight claims.

870,768. BOAT-PROPELLING DEVICE. WHITING ARNOLD, MANDARIN, FLA.

Claim.—1. The combination with a floating vessel, of a driving shaft provided with a craok, means for rotating said shaft, a bar pivotally coonected with the crank, a paddle on the lower eod of said bar, and a stay-rod pivoted at its lower end to the vessel and at its upper end to the upper end of the bar carrying the paddle. Two claims.

870,928. LIFE BOAT. ROBERT A. BROWN, CHICAGO.

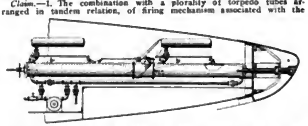
Claim.—1. A life boat comprising a closed outer shell, a car journaled within said shell on an axis disposed longitudinally, and free to rotate with respect to the ooter shell, said outer shell being of non-circular transverse section below the axis of said car aod beiog closer to said



car at each side of the axis thereof and near the middle of the bottom than at intermediate points, and ballast compartmeots formed at each side of the middle in the space betweeo the car and hull, the inner surfaces of said compartments being of substantially circular transverse section and concentric with the axis of said car, and said compartments being spaced apart to allow the car to hang close to the outer hull betweeo them. Three claims.

871,453. TANDEM TORPEDO TUBE. LAWRENCE Y. SPEAR, MILTON, MASS., ASSIGNOR TO ELECTRIC BOAT COMPANY, NEW YORK, A CORPORATION OF NEW JERSEY.

Claim.—1. The combination with a plorality of torpedo tubes arranged in tandem relation, of firing mechanism associated with the



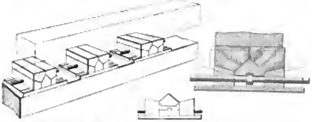
forward tube, meaos for establishing a firing passage from an after tube through the forward tube, and firing mechaoism associated with that after tube, whereby a plurality of torpedoes may be discharged in rapid successioo. Eleveo claims.

871,050. PROPELLER. FREDERICK A. DOUSE, SEATTLE, WASH.

Abstract.—This invention relates to the propulsion of marine or aerial vessels; and its object is the provision of devices of this character which will be of simple and inexpensive construction, and which are capable of propelling a vessel at a high rate of speed with a relatively small consumption of power. To these ends the invention consists of a flexible blade which is adapted to be swept from side to side, and to act against the buoyant fluid to propel the vessel through a succession of reacting impulses. Two claims.

871,467. KEEL-BLOCK FOR SHIPS. THOMAS H. ALCORN, PHILADELPHIA, PA.

Claim.—1. In a device of the character described, movable supports, blocks carried by said supports, and means in engagement with the supports for operating said supports whereby the blocks are lowered, and for returning said supports to their normal position. Seventeen claims.



871,469. AUTOMATIC COALING APPARATUS. AUGUST BLIEDUNG, HAMBURG, GERMANY.

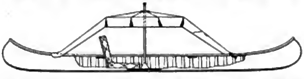
Claim.—In a coaling apparatus, a deck, a chamber beneath the deck and having lower openings, rollers within the chamber, a chain engaging the rollers and arranged in a plane parallel to the deck, and buckets carried by the chain. One claim.

871,544. DREDGE. JOHN B. WEBBER, JR., TOLEDO, OHIO, ASSIGNOR TO ALEXANDER BACKUS, TOLEDO.

Claim.—1. A hydraulic dredge having a suction pipe, a rotary head, a driving shaft therefor, a pivotal mounting for the shaft and pipe, and a thrust bearing for the shaft adjacent the mounting. Six claims.

872,088. CANOE AWNING. WILLIAM B. SHERMAN, DORCHESTER, MASS.

Claim.—2. In an awning, a plurality of ribs carrying an awning cloth, a supporting rod, an upper rib-ring moving freely on said rod, a sliding sleeve mounted on said rod, a lower rib-ring secured to the base of said sleeve, the top of said sleeve engaging with said upper rib-ring when the awning is opened, and maintaining said rings at a fixed distance from each other. Six claims.



872,389. BOAT. ELAH TERRELL, COLUMBUS, OHIO.

Abstract.—The invention has for its object the provision of a novel construction for a power-driven boat, the construction being such that the action of a propeller exhausts the water from in front of the boat and the follow wave, kicked up by the propeller, acts against an inclined plane bottom in such manner that the follow wave acts to drive the boat forward. Three claims.

British patents compiled by Boughton & Co., patent agents, 276 High Holborn, London, W. C.

14,617. VALVES. H. RUSTAD, LINDSAY, CANADA.

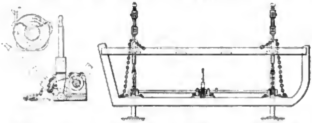
Relates to valves of the kind that can be ground after being seated. The screw spindle is in engagement with a nut having recesses in engagement with lugs in the bonnet, which covers the body portion of the valve casing. A spring tends to press the nut down. The lower end of the valve spindle is enlarged and provided with lugs which lie in recesses formed in the valve, the recesses being larger than the lugs, so that when the valve is fully down, the further turning of the spindle in either direction causes the valve to be ground in its seat. A nut secures the valve to the spindle.

15,888. MARINERS' COMPASSES. G. W. HEATH, CRAYFORD, KENT.

The gimbal knife-edges rest in saddle pieces, connected by horizontal springs to sockets on brackets, which are attached to the piece on the binnacle bowl by milled nuts. The cylindrical rim of the binnacle bowl has formed on it a second bead, between which and the upper bead engages the bolt of a locking device, for the binnacle top, which is operated by a pin engaging a cam groove in a rotatable cap. The cap rotates about the stud, and is limited in its movement by a notch in the cap engaging a stop on the base. The glazed bezel is attached to the compass bowl by studs thereon engaging a flange in a rotatable knob on the bowl, an opening in the flange allowing the stud to be inserted. For taking rapid cross-bearings, a glazed ring is rotatably fitted in the cover, and has hinged to it sighting-leaves; or a conical sight vane may be employed, provided with a graduated glass disk attached to the metal plate, which is rotatable on a spindle mounted on gimbals. A double pointer is secured to the hollow stem of the vane, which may be clamped to the spindle, which carries a fixed pointer.

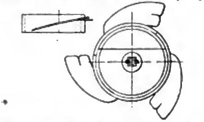
16,120. BOAT DISENGAGING GEAR. E. EKBLOM, PLAISTOW, LONDON.

The boat is suspended from hooks secured to chains attached to a rotatable shaft by other hooks. The shafts are mounted in bearings and are provided with arms normally secured by a lever. By removing a stop-pin and folding down the lever, the arms are released and the rotation of the shafts releases chains, putting the weight of the boat on the second chains. When the pull comes on these chains, hooks are drawn out of engagement with links, and the boat is released from the falls.



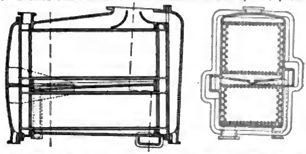
15,892. SCREW PROPELLERS. C. J. H. FLINDT, OROSUNDSGADE, COPENHAGEN, DENMARK.

In propellers formed of blades fixed to a relatively large hub, each blade is split longitudinally at the broadest end into two parts, the inner tip being of larger pitch than the outer.



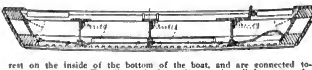
16,091. STEAM CONDENSERS. T. W. AND W. W. NICHOLS, GATESHEAD, DURHAM.

In a horizontal steam condenser of the concentric tube type the tubes are slightly inclined, while various draining passages are provided to carry off more rapidly the water of condensation. The outer and inner tubes communicate with end chambers formed by tube plates. The tubes are fixed to the tube plates by means of perforated sleeves and gland nuts, the arrangement of which may be slightly varied. The end compartment, divided by a diaphragm, is connected by ducts with the main chamber, which is also divided by a curved plate having a drain groove. Water flows through the annular spaces between the concentric tubes, and is caused by baffles, inserted in the end chambers, to pass backwards and forwards through the condenser.



16,369. COLLAPSIBLE BOATS. C. ADDISON WILLIAMSON, KOOLUNGA, SUFFOLK.

In collapsible boats of the kind which are formed with a rigid and approximately flat bottom and a gunwale connected to the bottom by flexible sides, the seats have legs hinged under them, by which the boat is maintained in its extended position. The bottoms of the legs rest on the inside of the bottom of the boat, and are connected together by a rope. To collapse the boat, the rope is pulled, causing the legs to assume a horizontal position. When the boat is in the open position, the rope is placed over a hook.



16,556. LOADING AND UNLOADING VESSELS. T. G. F. McCOMBIE, MONKSTOWN, DUBLIN.

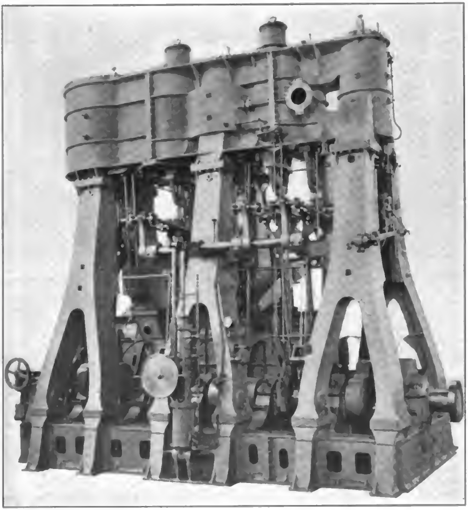
For coaling or loading ships at sea, a tube is connected at one end to a feeding apparatus on the collier and at the other end to a port in the side of a vessel towed by the collier, the joint being watertight. Bags of coal are fed along the tube on the collier, and are delivered into a flexible tube, which conveys them through the port into the vessel. The feeding apparatus consists of slide plates which engage a screw shaft and are thus moved along, pushing the bags in front. The slot in the bottom of the tube is turned at right angles, and so the slide plates on reaching this point automatically drop out of action.

International Marine Engineering

MARCH, 1908.

THE NEW BRAZILIAN LINER VERDI.

This new steamer, which was built and engined by Workman, Clark & Company, Ltd., Belfast, has been especially designed for the carriage of cargo and passengers between New York and the east coast of South America. She sailed from New York on her first trip on Jan. 20. It is the intention of her owners, the Lamport & Holt Line, to establish a semi-monthly service, three other similar steamers being now under construction. The construction of the vessel and machinery has been carried out under the supervision of the British Corporation surveyors to qualify for the highest class in their registry, while the requirements for the Board of Trade passenger certificate have also been fully complied with.



FRONT SIDE OF THE TRIPLE EXPANSION ENGINE OF THE BRAZIL LINER VERDI.

The ship is rated as a two-deck and shade-deck vessel, schooner rigged, and has a gross tonnage of 6,578 the net tonnage being 4,180. The length is 430 feet 4 inches, with a beam of 53 feet 4 inches and a depth of 43 feet 6 inches. With a draft of 24 feet 1½ inches the displacement is 11,200 tons, and the tons per inch are 46. When carrying dead weight of 7,650 tons the displacement becomes 12,400 tons, and the draft 26 feet 3½ inches. With 7,940 tons dead weight and a draft of 26 feet 10 inches the displacement is 12,690 tons. With 8,220 tons dead weight and 12,970 tons displacement, the draft is 27 feet 4½ inches. There are eight water ballast tanks, with a total capacity of 1,095 tons.

Special attention has been given to the first-class passenger accommodation, which is arranged amidships on the upper, shelter, bridge and promenade decks. One very noticeable feature is the great headroom of 9 feet between decks. The fifty-one staterooms for first-class passengers are designed for accommodating 102 persons. By making use, however, of the settees 153 may be carried. Arrangements are also provided for 52 second-class and 196 steerage passengers.

The large and well-appointed staterooms are arranged along the sides of the vessel, and designed to give the maximum of comfort in a hot climate. Several pairs of these rooms have communicating doors, so that they can be occupied as family suites if so desired. These staterooms are tastefully furnished in mahogany, and, the walls being enameled white, have a comfortable, cool appearance, which will be much appreciated in the warm climates for which the vessel is intended.

The dining saloon is a handsomely designed apartment, placed at the forward end of the bridge house and extending the full width of the vessel. The walls are paneled in light oak, with gold ornaments, while the ceiling is finished in white. The furniture, which is all in oak, of the same shade as the paneling, has been arranged on the restaurant principle, seats for 106 persons being provided. This apartment is efficiently lighted by large cottage windows at the fore and large round lights along each side. From the after end of the saloon a well-proportioned oak staircase leads up to the entrance hall on the bridge deck and the saloon lounge on the promenade deck. The entrance hall gives access to the bridge deck, at each end of which sheltered recesses have been arranged, and provided with comfortable garden seats.

The saloon lounge on the promenade deck is a luxurious apartment, the walls and ceiling of which are finished in white, the paneling being relieved with beautifully painted medallion portraits of the world's famous musicians, done in Bartolozzi style, the portrait of Verdi, the famous composer, being placed over the piano. The furniture, consisting of bookcase, writing tables, chairs and settees, is in light oak, the seats being upholstered in tapestry. The room is lighted by large cottage windows, shaded by dainty-colored silk curtains. The boat deck affords ample space for promenading, and on this deck is the smoke room which is handsomely paneled and furnished in walnut, the settees and chairs being upholstered in crimson leather. Adjoining this apartment, a well-sheltered alcove has been built and suitably furnished with tables and comfortable chairs, affording a pleasant lounge in the open air.

The sanitary arrangements and the ventilation of all the compartments have received especial attention, and will be found to be of the most up-to-date and satisfactory character, a thorough system of mechanical ventilation having been introduced. Second-class accommodation has been provided in the poop, where a number of commodious staterooms have been arranged at the sides of the vessel, with the dining saloon in the center. The captains' and officers' quarters are located in a steel house situated upon the bridge deck, convenient to the navigating bridge, while the engineers' and petty officers' rooms are placed along the starboard side of the vessel on the upper deck, convenient to the engine-room entrance.

The four large holds into which the cargo space is divided are almost entirely free from obstruction, the decks being supported by fore-and-aft girders in place of the usual system of hold pillaring. This arrangement affords ample space for the storage of the largest class of consignments, such as locomotives, railway carriages, boilers, etc., while in anticipation of this class of cargo the hatchways have been constructed as large as possible. Each of the hatchways is equipped with four steam winches of the most powerful type, with a suitable number of derricks, capable of handling a full cargo in the most expeditious manner.

The ship is propelled by one screw operated by a triple-expansion engine with cylinders 28, 47 and 78 inches in diameter and a stroke of 57 inches. This gives 3,850 indicated horsepower with 200 pounds boiler pressure and a designed speed of 12.75 knots. The speed on trial, Dec. 18, 1907, was 14.15 knots. The crank shaft has a diameter of 15⅞ inches, the line shaft 15 inches, and the propeller shaft 17 inches. The propeller is of bronze, with four blades, and has a diameter of 18 feet 6 inches. It is set to a pitch of 19 feet, which gives a pitch ratio of 1.026; the pitch is adjustable down to 18 feet. The engine room is 67 feet 6 inches long.

BROADSIDE VIEW OF THE LAMPORT & HOLT LINE STEAMSHIP VERDI, WITHOUT CARGO ABOARD.

There are three double-ended Scotch boilers, measuring 15 feet 6 inches in mean diameter by 18 feet in length. Three furnaces in each end of each boiler make a total of eighteen fires. These furnaces, which are corrugated, have each an internal diameter of 45 inches. The total heating surface of the boilers is 13,430 square feet, with 354 square feet of grate. This makes a ratio of 38 to 1. A single-ended donkey boiler, operating at 110 pounds pressure, measures 14 feet in diameter and 10 feet 6 inches long; it has three furnaces.

The regular coal bunker stowage capacity, figured on a basis of 43 cubic feet per ton, is 1,415 tons. On the same basis, the capacity of the reserve bunkers is 1,802 tons. This makes a total of 3,207 tons. It is estimated that the ship will require twenty-two days to reach the Rio Plata, and that the coal consumption will be 65 tons per day. This makes 1,430 tons, and with 40 tons for use in the harbors of Bahia, Rio de Janeiro and Santos, the requirement calls for 1,470 tons. As it is out of the question to obtain satisfactory coal in South America

at a satisfactory figure, the ship has to carry from New York enough coal for the round trip. There is provided for homeward steaming 1,510 tons and a margin of 150 tons, or a total of 1,660. This makes the total coal requirement on leaving New York 3,130 tons.

The equipment includes two Hall's bower anchors of 79 cwt. each, and one of 67¼ cwt.; a Rodgers stream anchor of 22¾ cwt.; a Rodgers kedge of 9½ cwt.; 300 fathoms of 2⅜-inch stud link chain, and 90 fathoms of 1 5/16-inch stream chain. There are two fresh water tanks, with a capacity of 5,950 gallons each.

THE HEATING AND VENTILATING OF SHIPS.

BY SYDNEY F. WALKER, M. I. E. E.

FORMS OF HEATING APPARATUS WITH HOT WATER.

Hot-water apparatus for heating rooms, cabins, alleyways, corridors and so on may consist simply of pipes laid around the rooms, the saloons, etc., and through the corridors; or, as is more frequently arranged, what are termed "radiators" may be employed. The term radiator is a misnomer. As is explained below, the heat delivered by the heating appliance is only partly by radiation. On the other hand, the plain pipes that were employed in the early days of steam and hot-water heating are quite as much radiators as the forms of apparatus usually so denominated. Any pipe in which hot water or steam is passing gives off heat at a rate directly proportional to the difference of temperature between the water and the air on the outside, and again in direct proportion to the extent of surface exposed, and directly to the conductivity of the substance of which the pipe is composed, and inversely in proportion to its thickness.

This law in its simple form is, however, applicable only to small differences of temperature and small values of temperature of the surrounding air. The heat is given out in two ways, by radiation and by convection. Heat passes from a heated body in all directions, through the air and whatever substances may surround it, by what is called radiation. Radiant heat, as the heat delivered by radiation is termed, has the peculiar property that it passes through air without delivering much heat to the molecules of the air itself. Heating from fires, stoves, etc., though it is due almost entirely to radiation, arises from the fact that the radiant heat is absorbed by the articles of furniture in the room, by the walls, etc., and is afterwards given out by them, partly by re-radiation, partly by convection, and partly by conduction. In addition to the above, any heated body present in air, as in any room, cabin, corridor, saloon, etc., gives rise to convection air currents. The air in the neighborhood of the heated body becomes warmer than that slightly removed from the body and is pushed upwards by the weight of the colder air, a fresh supply of air taking its place, becoming heated again, and so on, the result being that a continual circulation of air is produced, until the temperature of the room is raised to that of the heated body, or as long as heat is delivered to the body, and is carried off by the surrounding air. Every heated pipe and radiator, therefore, gives off heat both by radiation and by convection, or, as it is sometimes termed, by air contact.

Different bodies have different radiating properties. Cast iron, for instance, radiates 0.65 B. T. U. per square foot per hour for each degree F. difference of temperature between itself and the surrounding atmosphere; wrought iron, 0.57 unit; rusted cast or sheet iron, 0.67 unit. The heat distributed by convection is independent of the nature of the heated body, but varies with the form of the body. Cast iron, wrought iron, wood, etc., if heated to the same temperature, give rise to the same distribution of heat, but the quantity given off varies with the form. The quantity of heat delivered by any hot-water pipe or radiator depends directly upon the difference of temperature between the body and the air, upon the surface of the heated body exposed to the air, and upon its form. This again, as with radiation, is true only for low figures. When the difference of temperature between the heated body and the surrounding air does not exceed 30 degrees F., and when the temperature of the air surrounding the body does not exceed 60 degrees F., the above laws for radiation and for convection or air contact hold good; but when the difference of temperature exceeds the above figure, and when the temperature of the air surrounding the heated body exceeds 60 degrees F., the rate at which heat is delivered to the air increases, and at a very much more rapid rate than the increase of the difference of temperature.

The French *savants* Dulong and Petit experimented upon the subject some years ago, and their experimental facts have been confirmed by another French *savant*, Peclet, whose name will be remembered in connection with the laws of transmission of heat in refrigerating matters, and they have produced some very complicated formulae, which need not be given here, but from the results of which Mr. Thomas Box, whose standard book on "Heating" is well known, has worked out a table of what he terms ratios, representing the number by which the result of the simple laws referred to above must be multiplied, to give the correct results. The multiplier or ratio, as Box calls it, ranges from unity up to six. That is to say, the results obtained by applying the simple laws given above, for the quantity of heat delivered by a hot water or steam pipe, with a certain difference of temperature, and the other conditions as mentioned, have to be multiplied by a factor varying from a trifle over one up to six, to obtain the actual results. It will perhaps be sufficient if a few figures are given.

For a difference of temperature of 108 degrees, which is approximately that which would rule between the temperature of water in a hot-water radiator at 173 degrees F. and the surrounding air under conditions showing a temperature of 65 degrees F., the multiplier is 1.4. For a difference of temperature of 160 degrees F., which is what would probably rule with steam heating, the multiplier is in the neighborhood of 1.6. Approximately, therefore, for the conditions of heating by hot water or steam, the laws given above will show the quantity of heat delivered to the air, when a multiplier of 1.5 is brought into the equation.

Taking ordinary working conditions, the formula for the quantity of heat delivered by a hot-water radiator would be as follows:

$$Q = R\ (T - T_1) \times 1.4 + A\ (T - T_1) \times 1.4,$$

where Q is the quantity of heat in B. T. U. delivered to the air per hour, for each square foot of surface of the radiator exposed to the air; R is the rate at which heat is delivered by radiation; A that by convection, and T and T_1 are the temperatures of the radiator and the surrounding air.

It was mentioned above that the form of the heated surface exercises an influence upon the heat delivered to the air by convection currents, or, as it is termed, by contact. Thus a sphere delivers very much more heat per unit of surface, and with a given difference of temperature, than either a vertical or a horizontal cylinder. The apparatus most employed in heating, by hot water or steam, is either a horizontal cylinder in the form of pipes fixed as explained, or vertical pipes in the forms that have been given to radiators. For horizontal pipes, the quantity of heat delivered to the air in contact with the pipe, for every degree F. difference of temperature, and for every square foot of surface of pipe, for the pipes usually employed, is as follows: With 2-inch pipe, 0.728 unit; 3-inch, 0.626; 4-inch, 0.574; 6-inch, 0.523 unit. These figures are the values of A. For radiators the problem is rather more complicated, in the matter of convection.

The French savants referred to have threshed the matter out, and have produced some formulae applicable to all cases, as a result of their experiments, and the formulae are apparently pretty correct in practice. They are very complicated, however, and it will be perhaps sufficient if it be mentioned that heat liberated by convection from a sphere is considerably more for any given surface, and in a given time, than from a cylinder; and again the heat liberated from a horizontal cylinder, of a given diameter, is usually more than from a vertical cylinder of the same diameter. The rates for horizontal cylinders given above were taken from Mr. Box's book.

The rate with vertical pipes does not appear to have been measured, but Professor Carpenter* and others have made some very interesting experiments upon radiators of different forms, heated by steam and hot water. The radiators experimented on were of various forms, among them those shown in the drawings; also some consisting merely of iron pipes of different diameters and different lengths, arranged some horizontally and some vertically; also pipes and other arrangements with ribs cast on them, brass tubes plain and corrugated, and other forms. The net result of the experiments conducted by Carpenter, and by others whose work he quotes, appears to be a liberation of heat, the combined effect of radiation and convection, ranging from 1.25 B. T. U. per square foot of surface per 1 degree F. difference of temperature between the heated surface and the surrounding air, per hour, up to 2.89 B. T. U.

The best results are obtained with pipes or radiators of small sectional area, the highest having been obtained from a plain wrought-iron pipe 1 inch in diameter, 100 feet long, in a single horizontal line. Increasing the size of the pipes or the radiator equivalent, though increasing the total amount of heat liberated from a given length of radiator or pipe, decreases the rate per square foot per degree, etc. Fixing ribs upon the outsides of pipes, which has been adopted by some manufacturers, with the idea that the increased surface gives increased liberation of heat, are shown by the experiments quoted by Professor Carpenter to have the opposite effect. Thus, a plain cast-iron pipe without ribs liberated 2.54 B. T. U. per degree per hour, while a similar pipe, ribbed, liberated only 1.72 units. Cast iron gives better results than wrought iron, on account of its higher radiation, apparently, and brass gives a very low result. As mentioned above, the rule with practical heating and ventilating engineers is to estimate for a liberation of 1.6 to 2 units per degree F. per square foot per hour. In the writer's view, in laying out heating appliances, it will be wise to estimate for the liberation of heat at a rate not exceeding 1.5 B. T. U. per square foot of surface of the radiator exposed, per 1 degree F. difference of temperature, per hour.

It will be easily understood that the above are standard figures, and that for any given increase of temperature desired, say of the air in a room, all that is necessary is to convert the rate of liberation of heat given into increase of temperature of air, and then to divide by the number of degrees by which the air temperature is to be increased. Thus, 1 B. T. U. will raise by 1 degree F. the temperature of about 55 cubic feet of air, if in the neighborhood of 60 degrees F., or, it will raise the temperature of 11 cubic feet by 5 degrees F., and so on. All that is required to find out what quantity of heating surface is necessary, is to apply the following formula: $S = \dfrac{C\ (T - T_1)}{55 \times 1.5 \times (T_2 - T_1)}$ where S is the radiating surface in square feet; C is the cubical contents of the room to be heated, in cubic feet; T_1 is the temperature of the air when heat is applied; T that to which it is to be raised; T_2 that of the radiator.

In the above it will be understood that the question of ventilation has not been considered at all. Heating appliances are considered entirely by themselves, and on the supposition that the common practice is followed, of placing the heating apparatus in any convenient position in the cabin, saloon, etc., and irrespective of any mechanically-produced air current; and the heating effect produced by the apparatus is such as would follow on the lines of what would be called natural ventilation. The temperature of the room in which the appliance is fixed is raised to a certain figure by the operation of radiation and convection currents as explained, but without any control having been exercised over the air.

Also, in the above formula the heating up of air only is considered when the room is cold and heat is turned low; but

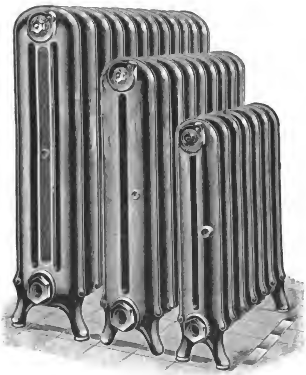


FIG. 9.—DOUBLE-TUBE AND SINGLE-TUBE RADIATORS FOR STEAM OR HOT WATER.

the formula also applies when the room is at its required temperature, and the heating appliance has to make good the heat lost by conduction through the walls of the room, by air currents, etc., if T is taken as the temperature to which the air in the room would otherwise fall in any given time. This is dealt with farther on, when explaining how the heat lost from the room is made up.

Another point that should be mentioned is the effect of the velocity of the flow of water through the pipes. The velocity of the flow of air over radiators, etc., and its effect, will be dealt with when discussing the heating of air, but it may be mentioned that, as is well known to marine engineers, the rate of delivery of heat from a hot-water pipe increases with the velocity of the water, up to a certain figure. The writer believes that experiments have not yet been made with a view of showing what the critical figure is, but, within the limits of ordinary hot-water heating appliances, every increase of the rate of flow tends to increase the heat delivered.

Another point should be mentioned in connection with both

* Cornell University, Ithaca, N. Y.

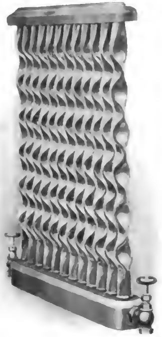


FIG. 10.—BOYLE RADIATOR ON SIR THOMAS LIPTON'S YACHT. BOW'S TUBES GIVE FLEXIBILITY AND LARGER HEATING SURFACE.

steam and hot-water heating The radiator has been developed because of the necessity of arranging a large surface of pipe within a comparatively small compass, and in such a form that it can be fixed in rooms, etc., without inconvenience. Forms of the radiator are shown in Figs. 9, 10 and 11. As will be seen, the radiator is simply a pipe arranged in a particular manner. A favorite form consists of a number of vertical columns, each column consisting of a single pipe, a loop of pipe, or two, three or four columns; the whole of the columns being held together and standing on feet, raising them a few inches above the floor. The pipes forming the columns are arranged in more or less ornamental form, and their outside surfaces are given the forms shown, in order to present as large a surface as possible to the air which passes through them and over them. As will be explained when dealing with warming air by means of radiators, special arrangements are sometimes made to direct the air over the whole of the surface of the radiator before passing into the room.

The columns of which the radiators are composed are arranged with channels at top and bottom, which, when the columns are assembled together, form pipes for the steam or water, both communicating with the tubular spaces inside the columns. Also, as will be seen from the drawings, it is arranged in nearly all forms of radiators that connection can be made to either end of the channels referred to, at top or bottom, so that the hot water or steam can be brought to either end of the radiator, and where a return connection is made, that also can be taken from either end. This is the usual form, but it will be understood that any design may be arranged that will provide for the connection between the water or steam supply and the radiator, and for the circulation of the steam or water through the individual columns, and for the connection to the return, where there is one.

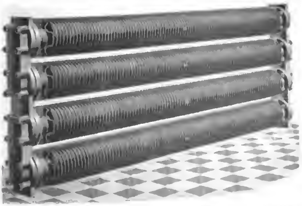


FIG. 11.—KOERTING'S RADIATOR FOR STEAM OR HOT WATER, CONSISTING OF PARALLEL HORIZONTAL RIBBED PIPES, CONNECTED TO HEADERS AT EACH END.

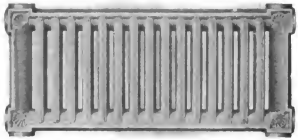


FIG. 12.—RADIATOR FOR HOT WATER OR STEAM. NATIONAL RADIATOR COMPANY.

Radiators are arranged to go into all sorts of confined spaces, such as cabins. Figs. 12 and 13 show the Colonial radiator, made by the National Radiator Company, of Chicago and London, which has been fitted on board H. M. S. *King Edward VII*. It is arranged to be fixed on brackets, secured to bulkheads, at any convenient height, as shown. One method of fixing to walls is shown in Fig. 14. Its great feature is, as will be seen, the fact that it will lie close to a bulkhead, or to the ship's side. It is made in three sizes, respectively, 29, 23 and 16¾ inches long, all 13¼ inches high, and 2⅝ inches deep. When fixed a little way from the bulkhead, the space occupied is very small, and it can be built into any convenient form, several of any size being connected together by right and left-hand threaded nipples, and arranged side by side vertically or horizontally, as may be convenient Thus, a number of them may be arranged under the seats around the stern of a ship, or in any other situation.

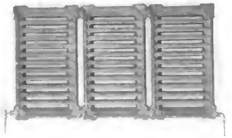


FIG. 13.—BATTERY OF COLONIAL RADIATORS FIXED VERTICALLY.

A form of radiator that is a great favorite in hospitals is fitted with hinges at one end, the valves passing through the hinges so that it can be turned back against the wall or brought forward into the room. It appears to the writer that this form would also be useful for cabins and other confined spaces on board ship. It is shown in Fig. 15.

Radiators can be arranged to suit any style of decoration, and practically to fit any space. They may be painted to match the decorations of the cabin or saloon, and they are frequently ornamented in various ways, the castings from which they are formed having an ornamental pattern upon them, the decorative work being afterwards added by artists. In

FIG. 14.—SIDE OF SINGLE-LOOP RADIATOR. NATIONAL RADIATOR COMPANY.

the hot-water radiator it is usual to bring the connection of the supply pipe to the top of the radiator, and that from the return pipe to the bottom. An air cock or valve should be fitted on each radiator at the end, away from the supply service and at the top, and it should be seen that it is always in order. For positions where appearance is not of consequence, as in the forecastle, and in emigrants' quarters, the radiator may take the form of a grid of iron pipes.

There is another system of hot-water heating that has been fixed in some yachts, known as the Reck, which is the invention of a Danish engineer of that name. In this system the heating effect of steam directly injected into a body of water is combined with the effect of the same steam passing around a body of water, on the lines of the feed-water heater. There is a boiler for generating steam, fixed at the lowest part of the system (it would be in the stoke hold on board ship), and a little above the boiler is an apparatus termed by the inventor a "reheater," a device similar to a feed-water heater. At the top of the system is the principal heating apparatus for the water. It is termed by the inventor the "circulator." There is the usual expansion tank above the circulator, and immediately below the circulator is another apparatus called the condenser. Steam is taken directly from the boiler by a pipe to the reheater, where it passes around the pipes, through which the return water from the circulating system is passing, and another pipe is taken from the top of the reheater to a point above the circulator. This pipe is curved around at the top into an inverted U, and is brought into the top of the circulator. From the lower part of the expansion tank a pipe passes to the upper part of the circulator, and a second pipe is also taken from the lower part of the expansion tank along the upper portion of the upper rooms, or the upper deck, to be warmed, and from this the circulating pipes to the radiators are taken. The expansion tank is fitted with a cover; a second pipe passes from its upper part to the condenser, and another pipe from the condenser to the water space of the boiler. The return pipe of the circulator system, which passes along the lower rooms, or the lower deck, to be heated, is connected to the reheater, a second pipe conveying the heater water to the circulator.

The working of the arrangement is as follows: The circulator, being full of water which has returned from heating the radiators, is heated by steam delivered directly from the boiler through the pipe mentioned. When heated, it overflows into the expansion tank and thence to the pipe forming the main flow pipe of the hot-water circulating system. Branch pipes connect the main flow pipe with the return pipe at the bottom, and radiators are connected to these branch pipes in a manner which may be compared to the shunt system in electrical work. The radiators are bridged or shunted across a portion of the vertical pipe. The heated water, having passed down through the vertical pipes and the radiators, returns to the reheater by the return pipe, is there heated by the steam circulating around the pipes through which the water is passed, and thence again commences its outward journey, passing up the pipe to the circulator, where it is further heated by steam, and so on.

The condenser is similar to the usual surface condenser, with which marine engineers are familiar. It consists of the ordinary cylinder, with a series of tubes, arranged either in a vertical or horizontal position as may be convenient. This device condenses the steam which is delivered in the circulator, but which is not fully employed in heating the water for the circulation system, and which finds its way through the pipe into the expansion tank, and thence rising in bubbles, in the well-known manner, passes out of the top of the expansion tank by the pipe leading to the condenser. It is condensed by the flow of the water coming from the reheater,

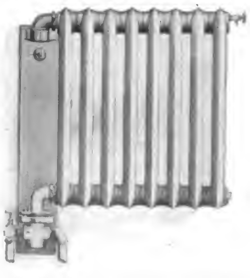


FIG. 15.—SWINGING RADIATOR OF NATIONAL RADIATOR COMPANY. THE VALVES ARE IN THE HINGES.

the condensed water being carried off by a pipe to the water-space in the boiler.

It will be noticed that the water receives heat from the steam at three places; in the circulator itself by direct contact, in the reheater and in the condenser. Further, the delivery of steam from the circulator into the closed expansion tank, by setting up a certain pressure above the water in the expansion tank, causes the water to run freely in the circulating system, quite apart from the circulation caused by difference of temperature, etc. The water-supply service is usually connected to the expansion tank with a ball cock, in

the usual way, cold water being added to the system when required and passing directly into it.

The advantage claimed for the Reck system is, that heat will be got up very much more quickly by its aid than with the ordinary system of hot-water service that has been explained. On the other hand, it is rather more complicated than the simple hot-water system, but the apparatus of which it is composed should present no difficulty to marine engineers. The main source of heat is usually a boiler on shore, and, in places where there is no other steam supply, can, of course, be steam from the ship's boilers, or the exhaust steam from the engines or auxiliaries, or any other convenient source.

(To be Continued.)

Under the plenum method the air may be supplied in either of two ways: First, by making the ashpit practically air tight, and then forcing into it the air in sufficient quantity and under the requisite pressure. Evidently, the only escape for the air being through the fuel, it must all be utilized for the purposes of combustion. Second, by making the fireroom itself practically air tight, and maintaining therein the required air pressure by means of a fan of sufficient capacity to constantly make good the amount of air which, under pressure, passes to the ashpits and thence through the fuel.

Under the vacuum method there is practically only one means of application—that by the introduction of an exhausting fan in the place of a chimney. This is commonly known as the "induced" or "suction" method. The fan thus serves

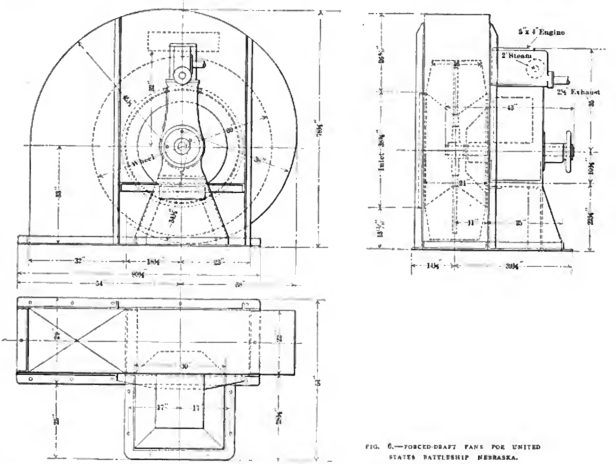


FIG. 6.—FORCED-DRAFT FANS FOR UNITED STATES BATTLESHIP NEBRASKA.

MECHANICAL DRAFT IN MARINE PRACTICE.

BY WALTER B. SNOW.

(Concluded.)

Although the term forced draft has been generally employed to distinguish artificial from so-called natural draft, yet, properly speaking, it should be denominated mechanical draft. The reason is evident in the fact that the two methods of artificial draft production are now classified as the forced and the induced, or more properly the plenum and the vacuum methods. Although both were experimented upon by Stevens in 1827 and in the succeeding years, yet the former remained for a long period practically the only form in which mechanical draft was applied. As the term implies, the air under the plenum method is forced through the fire; that is, the pressure maintained below the fire is greater than that of the atmosphere. Hence, the general term "forced" draft.

to maintain the vacuum which would exist if a chimney were employed, and its capacity can be made such as to handle the gases which result from the process of combustion. A short and comparatively light stack usually serves to carry these gases sufficiently high to permit of their harmless escape to the atmosphere.

Evidently, the method of application to be adopted must depend upon the circumstances. It cannot be said that under all conditions any one of these three principal methods, or their numerous modifications, is superior to the others. A combination of both the forced and the induced methods, if properly controlled, may give almost ideal results.

The closed ashpit system was naturally first applied, because of its ready adaptability to existing conditions. But unless special arrangements are provided, the air may be improperly distributed in the ashpit, and with intense draft, holes be blown through the fire, and the grate bars thus

overheated wherever the draft is concentrated. The pressure within the ashpit and the furnace chamber causes all leakage to be outward. The tendency is, therefore, to blow the ashes out of the ashpit and the flame, smoke and fuel out of the fire doors, but with slight effect in the case of stationary boilers at moderate rates of combustion. In the marine service inconvenience from this source is avoided by fitting the boilers with false fronts, within which the air pressure is maintained. By a proper arrangement of double doors and dampers, the disadvantage and danger from flame is completely overcome. The mere arrangement of dampers so connected to the doors that they close when the fire doors are opened is of great advantage. The false front further presents an excellent, yet simple, means of admitting air above the fuel, a feature which enters into most arrangements of this character. The conditions which have to be met in some cases of marine practice are exemplified in Table V., in which are presented the results of three tests of the air pressures produced by fans on the old U. S. S. *Swatara*, which was equipped with Kafer's closed ashpit system.

TABLE NO. VI.—SAVING BY FORCED DRAFT ON S. S. *Dania*.

Conditions, Four Voyages Each.	Days Steaming.	Knots.	Consumption of Coal per Day	
			Propulsion.	For all Purposes.
Natural draft	17.00	7.50	9.73	10.70
Forced draft	16.21	7.58	7.76	9.31

TABLE VII.—TEMPERATURES IN TUBES OF MARINE BOILER.

Location, from combustion chamber	Temperature	Location, from combustion chamber	Temperature
1 in.	1,466	1 ft. 2 in.	1,368
2 in.	1,426	1 ft. 8 in.	1,295
3 in.	1,405	2 ft. 8 in.	1,198
4 in.	1,412	3 ft. 8 in.	1,106
5 in.	1,398	4 ft. 8 in.	1,015
6 in.	1,406	5 ft. 8 in.	926
7 in.	1,400	6 ft. 8 in.	887
8 in.	1,410	In smoke box	782

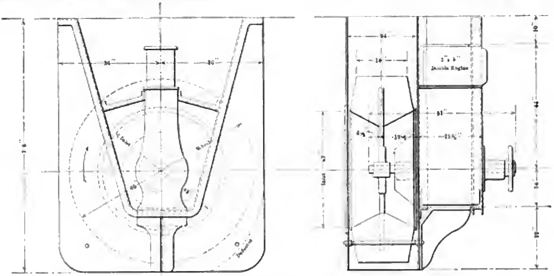


FIG. 7.—FIRE-ROOM BLOWERS FOR UNITED STATES CRUISER CHICAGO; 66-INCH FAN WITH DOUBLE ENGINE.

TABLE NO. V.—AIR PRESSURES IN CONNECTION WITH BOILERS OF U. S. S. *Swatara*.

Air pressure in conduit	2.87	4.76	3.48
Air pressure in ashpit	2.08	4.01	2.34
Air pressure in furnace door frame	1.86	3.61	2.13
Air pressure in furnace	1.63	3.18	1.75
Air pressure in uptake	0.13	0.10	0.07
Revolutions of fan per minute	438.6	584.8	476.6

The practical results of the introduction of the closed ashpit system in place of natural draft are clearly shown in the record (Table VI.) of four voyages of the steamship *Dania* under each of these conditions. The total consumption of coal per day was reduced 13 percent, while the time occupied in making the voyage was decreased nearly 5 percent. This method of application also presents an opportunity which it shares in general with the induced draft system, and in some degree with the closed fire-room system, for utilizing the heat of the waste gases.

The variation in the rate of absorption of heat from the gases, which takes place in their passage through the tubes of a Scotch type marine boiler, is clearly shown (Table VII.) by the results of tests of a boiler worked at its normal capacity, the rate of combustion of coal being relatively low—only 17 pounds per square foot of grate per hour. The temperature existing in the combustion chamber was 1,644°, and that just inside the tube, 1,550°. Experiments with one of the Babcock & Wilcox watertube boilers of the *Cincinnati* showed a temperature of escaping gases ranging from 466° to 640°, with corresponding rates of combustion of 19.61 and 50.38 pounds of coal per square foot of grate per hour. These results all point to a wastefulness which may be reduced by introducing additional devices to abstract a larger proportion of the heat from the gases.

Simplest among such devices for fire-tube boilers are to be classed the Serve tube and the retarder. The former consists of a number of radiating ribs extending the full length of the interior of the tube, and presenting extra surface for the absorption of heat. The latter is a helically twisted strip of sheet iron of long pitch, inserted in the tube, which breaks up the current of gas and forces all portions of its volume into touch with the inner surface of the tube. The influence of these retarders in the case of a 100-horsepower boiler is shown in Table VIII. With the rapidly increasing use of the watertube type of boiler, the economic opportunity for the retarder is rapidly vanishing.

In other systems which have been extensively introduced in connection with marine boilers, tubes are interposed in the uptake. Through these the gases pass while the air is forced or drawn across them and down through a false front

Table VIII.—Reduction in Temperature of Flue Gases and in Coal Consumption by the Use of Retarders.

Horsepower Developed	Reduction in Temperature of Flue Gases Degrees Fahr.	Reduction in Coal Consumption Percent.
52	20	0.0
75	53	0.0
100	32	3.2
125	46	4.0
150	19	3.3
170	59	3.6
200	36	4.1
225	26	8.6
239	123	18.4

to the ashpits. A suitable arrangement of doors and dampers provides for partial admission above the fire, and for opening and closing the doors without objectionable results.

The adoption of the closed fire-room system, in which a plenum condition is maintained in a practically air-tight fire-room, is largely the result of conditions. It lends itself admirably to the necessities of vessels in actual warfare, for it is essential that the openings down to the engine and boiler rooms should be kept as small as possible; and in all cases the machinery department would be closed down and the air supplied by artificial means during an engagement. In a war vessel with protective deck and minute watertight subdivisions it is extremely difficult where there is a large number of boilers to so arrange the blowers for closed ashpit draft as to ventilate the fire-room thoroughly. Fans installed upon the closed fire-room principle can be easily arranged to ventilate the engine and fire-rooms as well as to increase the combustion rate. They thus perform a double duty, and avoid the use of a second set, were this arrangement inadmissible.

The conditions existing in the naval marine are, however, decidedly different from those in the merchant service. The absence of the protective deck, the opportunity for open fire-rooms and the greater space which is usually available, generally make possible the closed ashpit system in the merchant marine, and thereby insure clean and comfortable fire-rooms. In the case of the warship, its maximum steaming capacity is seldom demanded, and then only for a comparatively short time, as during an engagement. By the employment of mechanical draft it is possible to construct the machinery within the limits of space and weight which are sufficient for ordinary service, while the reserve of power is stored in the light fans and fittings, instead of in the cumbrous boilers and machinery. In this fact is summarized one of the most important advantages of mechanical draft for marine purposes.

Under ordinary cruising conditions, where the stacks are of moderate height, the fans may not be required, but they must be of form, construction and capacity sufficient to meet at an instant's notice the maximum demand that may be made upon them. For instance, a vessel of the cruiser type, which may be required in case of necessity to develop 9,000 to 10,000 horsepower, may at the usual cruising speed of 10 or 12 knots require only 1,500 to 2,000 horsepower. These conditions are well exemplified by the results in Table IX. of a series of tests of the late U. S. S. *Charleston* at various rates of speed. The rapidly increasing horsepower with increased speed is to be noted, as is also the far more rapid increase in the power of the blowers, made necessary to

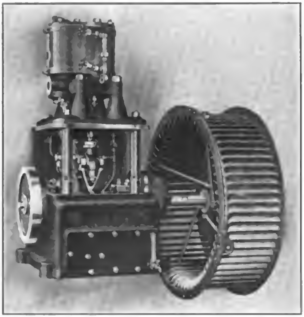
Table IX.—Results of Tests of U. S. S. *Charleston*

Speed in Knots.	13	14	15	16	17	18
I. H. P. main engines	2,220	2,820	3,550	4,370	5,220	6,120
Coal per I. H. P. per hour	2.2	2.1	2.0	1.9	2.1	2.5
I. H. P. of blowers	0.0	2.5	6.4	17.6	36.8	69.6
Nautical miles per ton of coal	4.34	4.00	3.68	3.41	2.84	2.22

meet the requirements. The relation between the actual efficiency, as is shown in the coal per indicated horsepower and the nautical miles per ton of coal, is of interest as indicating the difficulties in the way of obtaining even a slight increase of speed when it is well up to the maximum.

The fans first employed with the closed fire-room system were frequently of the inclosed type, often from necessity, because the fan was placed outside the fire-room. This type, shown in Fig. 6, has gradually given way to a form of construction employed in fans suspended overhead in the fire-room, in which the rim or roundabout is partially or entirely discarded, although direct contact with the rapidly revolving wheel is prevented by an arrangement of wire netting. This construction is shown in Fig. 7.

Among the advantages of the closed fire-room system is that of preventing all escape of flame and smoke into the fire-room; the leakage being all inward to the fires. This feature is preserved in some recent equipments in which stack



THIRTY-INCH SIROCCO BLOWER ON STEAM YACHT VIRGINIA, DIRECT CONNECTED TO A 5 BY 5-INCH FORBES ENGINE.

heaters are provided without direct connection to the blowers. The pressure within the fire-room is, however, sufficient to cause a flow of air between the tubes through which the hot gases pass, and thence down through false fronts to the ashpits as well as to openings above the fire. Pressures in fire-room and ashpits are thereby balanced.

The induced system, whereby a partial vacuum is produced within the furnace, is substantially the same in its effect as a chimney, which it most closely imitates in its action. Its leakage is always inward, avoiding inconvenience from flame and smoke at the fire-doors. On shipboard it produces excellent ventilation with open fire-rooms, thereby reducing their temperature. It is cleanly, lends itself readily to control by the dampers which may be introduced for the purpose, and can by simple means be rendered absolutely automatic, requiring no attention whatever from the fireman.

The early objection to this system, before it had been extensively adopted, was that the fans could not stand the high temperature of the gases passing through them. The best refutation of this statement lies in the fact that large numbers of fans have been running for years under these conditions, handling gases from 500° to 800° in temperature Of course, these fans require to be of special construction to

withstand the heat, and must be provided with means for keeping the bearings cool. But these features were long ago introduced, and to-day the decision between a forced or an induced system is to be made independently of the question of durability of the fans.

The induced system presents an excellent opportunity for the introduction of air or water heaters which are to abstract the heat from the waste gases, thereby securing one of the greatest possible economies in the modern boiler plant, be it on land or sea. The reduction in temperature which may be thus secured not only increases the efficiency of the plant, but has an appreciable effect upon the proportions of the fan; for upon the temperature of the air and gases which pass through the fan must depend its size and speed to accomplish the desired results in the way of draft production.

Under the plenum or forced system, the volume of air supplied to the fire is substantially the same as that delivered by the fan, making no allowance for leakage. But with induced draft the fan must handle a volume of air and gases which, although the same in weight, is greater in volume practically in proportion to its increase in absolute temperature. Disregarding leakage, the weight is greater than the air admitted, by that portion of the coal which has entered into chemical combination with it. On a basis of 18 pounds of air per pound of coal, this additional weight amounts to 5.5 percent, while with a supply of 24 pounds it is 4.2 percent. This increased amount may enter into any refined calculations of fan capacity, but it is unnecessary to go into the detail of making allowance for difference in specific gravity, or for moisture in the air or fuel.

As the capacity of a fan, both in volume handled and pressure produced, is easily varied by a change in speed, sufficient accuracy is secured in ordinary design by considering that air is the fluid handled, and that the volume is proportional to the absolute temperature.

Not many years since it was asserted by a well-known authority that "ten years ago one ton of cargo was carried 100 miles for 10 pounds of fuel. Now—with the great increase in size of ships and other mechanical improvements—the same work is done for about 4 pounds of coal." And still there remains room for further improvement.

The German Navy.

Beginning with an act of the Reichstag in 1898, Germany has been working on a definite program, worked out for several years in advance, in connection with the enlargement of the navy. Three times since the act of 1898 there have been enlargements in the program, and there seems to be now a strong sentiment in favor of placing the German navy upon a very high plane of power and efficiency.

The act of 1898 contemplated the construction within a few years of twenty battleships, eight coast defenders, twelve large and twenty-nine small cruisers, besides six destroyers to be laid down annually. A number of these ships were already in being, and the program called for the construction of two or three large ships every year to complete the total number. The act of 1900 increased the battleships to thirty-eight, the large cruisers to fourteen and the small cruisers to thirty-eight. The act of 1906 increased the large cruisers to twenty and doubled the number of destroyers, requiring twelve to be laid down each year. The act of 1907 decreased the active life of all vessels from the twenty-five years contemplated in previous programs to twenty years, thereby automatically increasing the amount of new construction to take the place of vessels passed into the reserve.

The program of 1908 calls for a still further increase, it being estimated that during the next three years there will be built each year three battleships and one armored cruiser, the idea being that by the end of 1914 Germany will have completed a fleet of sixteen battleships of the *Dreadnought* type and five vessels of the *Invincible* type. Six years later it is expected that there will be a total of forty-seven battleships and twenty armored cruisers, of which thirty-two battleships will be larger than the British *Dreadnought*. It is thus the aim of Germany to stand second to England, displacing the United States from this position.

SCOTCH SHIPBUILDING IN 1907.

BY BENJAMIN TAYLOR.

The year 1906 was a record one in shipbuilding, and its output exceeded that of all its predecessors. It cannot be said that the output of 1907 exceeded that of 1906 in all the United Kingdom, but it did in Scotland, which thus again stands foremost in all the shipbuilding centers of the world. Drawing together the figures for the whole kingdom as collected (and I take the figures compiled by *The Glasgow Herald*, knowing that they are very carefully revised) we have the British total as 1,825 vessels, 1,814,961 tons and 1,776,768 indicated horsepower; a decrease on the year of 187,610 tons and 69,235 horsepower. The number of vessels increased by 454, owing to the many small vessels built. The table summarizes the work of the year:

	1907, Ships.	Tons.	I. H. P.	1906, Ships.	Tons.	I. H. P.
Scotland	757	675,173	742,299	511	658,830	670,431
England	1,030	1,001,246	952,239	832	1,193,881	1,028,352
Ireland	38	138,542	82,230	28	149,860	147,220
Totals	1,825	1,814,961	1,776,768	1,371	2,002,571	1,846,003

The foreign returns so far show that 1,509 vessels were built, aggregating 1,432,589 tons and 1,335,458 indicated horsepower, as against 1,344,715 tons and 1,318,345 indicated horsepower in 1906. From the British colonies, returns have come of 189 vessels of 36,344 tons and 14,023 horsepower launched in 1907, as against 109 vessels, 28,272 tons and 18,395 horsepower in 1906. This gives an approximate world total for 1907 of 3,523 new vessels put into the water, of 3,277,894 tons and 3,127,149 horsepower, as compared with 2,757 vessels, 3,375,958 tons and 3,182,744 horsepower in 1906.

To come now to Scotland, the large numbers of trawlers and drifters built last year increased the number of vessels considerably. The table shows the work done in the Scottish shipyards:

District.	1907. Ships.	Tons.	I. H. P.	1906. Ships.	Tons.	I. H. P.
Clyde	536	619,919	668,527	372	598,841	606,000
Forth	56	21,370	23,342	39	17,120	13,626
Tay, etc.	39	17,672	30,395	27	30,440	31,372
Dee and Moray Firth	134	16,212	20,035	73	12,429	18,634
Total	757	676,173	742,299	511	658,830	670,431

That the Scotch output should exhibit an increase when everybody expected, and all the rest of the country experienced, a decrease, must be attributed to the wonderful versatility of the Clyde shipbuilders, who turn out every description of floating craft, from the biggest of battleships to the smallest of barges. The total tonnage has been materially increased by the large number of fishing steamers and other small craft that were built, though there were large vessels also.

The leading firm in 1907 was Messrs. Russell & Company, Port Glasgow, with a tonnage larger than they had in 1906; and the Fairfield Company, Barclay, Curle & Co., Wm. Hamilton & Co., and Alex. Stephen & Sons follow, in the order given. The following is a summary of the returns of the Clyde builders:

	1907, Ships.	1907, Tons.	1907, I. H. P.	1906, Tons.	1906, I. H. P.
Russell & Co.	14	71,706	......	63,338	......
The Fairfield Company	6	48,020	112,000	20,063	29,380
Barclay, Curle & Co.	6	47,362	40,532	33,698	25,310
Wm. Hamilton & Co.	10	44,306	......	35,360	......
Alex. Stephen & Sons	9	44,094	35,900	22,982	18,700
Charles Connell & Co.	9	40,298	......	31,106	......
D. & W. Henderson & Co.	17	35,886	30,300	33,187	23,950
John Brown & Co.	7	35,293	73,000	46,387	108,900
Wm. Denny & Bros.	20	34,418	63,200	40,632	44,200
A. Rodger & Co.	5	22,674	13,775	19,895	8,300
Archd. McMillan & Son	8	21,318	......	23,276	......
Scott's Shipbuilding Co.	10	20,916	11,700	33,190	50,100
Napier & Miller	7	19,785	......	10,740	......
Green'k & Grangem'h Co.	8	16,337	......	22,112	......
Wm. Beardmore & Co.	3	14,500	11,000	21,000	4,000
Clyde Shipbuilding Co.	6	10,981	12,600	11,096	10,800
Ailsa Shipbuilding Co.	22	10,778	8,000	9,388	......
Murdoch & Murray	7	6,850	......	2,559	......
Caird & Co.	1	6,437	7,700	26,778	17,000
Fleming & Ferguson	16	6,153	9,100	5,601	8,300
Ross, Duncan & Co.	2	5,961	10,735	10,710	11,635
Lobnitz & Co.	26	5,772	6,760	4,539	6,195
London & Glasgow Co.	1	5,580	5,300	13,154	13,100
*David Rowan & Co.	..	......	50,220	......	45,850
*Rankin & Blackmore	..	......	29,250	......	23,200
*Dunsmuir & Jackson	..	......	26,250	......	41,325
*John G. Kincaid & Co.	..	......	22,750	......	18,000
*W. V. V. Lidgerwood	..	......	16,540	......	14,296
*Muir & Houston	..	......	10,470	......	11,200
All others	290	43,906	61,415	58,161	72,790

* Built machinery only.

The total number of vessels was 199 sail and 327 steam.

An increase of 61,927 indicated horsepower in the marine engineering output of the Clyde is explained by the Fairfield Company, which firm alone has an increase of 82,620 horsepower. John Brown & Company, first in 1906, with 108,900 horsepower (which included the turbines of the *Lusitania*), are second in 1907 with 73,000 horsepower; Denny & Company, third, with 63,200; Rowan & Company, fourth, with 50,220, and Barclay, Curle & Company, fifth, with 40,532 horsepower. In the work of the Fairfield Company were included the turbines for H. M. S. *Indomitable** and *Bellerophon,*† and the two Mediterranean steamers *Heliopolis*‡ and *Cairo;* in that of John Brown & Company, the turbines for H. M. S. *Inflexible,** the Harwich-Holland boat *Copenhagen,* and the Fishguard-Rosslare boat *St. Andrew.* Denny & Company constructed turbines for half a dozen vessels.

Twelve years ago the highest Clyde ship output was under 400,000 tons. In 1896 the industry began an upward movement, which has continued until now. In 1901 the half million point was reached, and now the total is over 600,000 tons. The increase alone represents the entire production of an average shipbuilding district. Such a rate of advance as the river has experienced cannot continue forever, and it is just a question of whether the stopping place has now been reached. Twelve months ago it was thought that it had arrived. There was a record output for 1906, and trade was obviously on the decline. But the Clyde has wonderful ability for turning out unexpected tonnage never heard of in the way of contracts, such as barges, lighters, pontoons and other craft shipped abroad in parts, which do not figure in the books of the registry societies. They are not measured by the Board of Trade, but yet they represent a large amount of shipbuilding material and shipyard labor. With these contrast the big cruisers at Fairfield and Clydebank, two big Mediterranean turbiners at Fairfield, two Allan liners at Linthouse and Whiteinch, and three Pacific steamers at Beardmore's Dalmuir. There was also more tonnage of dredging craft produced at Renfrew, Paisley and Port Glasgow. There was no large vessel in the list at all approaching the *Lusitania*** in tonnage, but, in spite of this, the total breaks the record of 1906, in consequence of the variety of work done on the river. The high total is wholly made up of ordinary everyday vessels—cargo steamers most of them, with, as already indicated, an unusually large proportion of vessels of the barge, lighter and fishery types.

The different types of vessels represented in 1907 were: Screw steamers, 192; barges, etc., 186; fishing craft, 31; dredging plants, 29; sailing yachts, 25; launches, etc., 24; tugs, 13; turbine steamers, 9; stern-wheel steamers, 6; warships, 3; steam yachts, 2; barque, 1; motor vessel, 1; turbine yacht, 1; railway ferry, 1; cross-river ferry, 1; motor yacht 1.

Among the "screw steamers" were the Allan liners *Corsican,*† *Grampian* and *Hesperian*—the first of 11,637 tons, and the other two of 10,000 tons each. The turbine steamers were the Mediterranean liners *Heliopolis* and *Cairo,* built at Fairfield, five vessels at Dumbarton—two for the South Eastern & Chatham Railway Company, two for the Nippon Petsudo Kwaisha, of Tokio, and one for the Union Steamship Company, of New Zealand; and two vessels built at Clydebank—one for the Great Eastern Railway Company's Harwich and Hook of Holland route, and the other for the Fishguard-Rosslare service. There were also King Edward's new turbine yacht at Pointhouse, and the turbine cruisers *Indomitable* and *Inflexible* at Fairfield and Clydebank, respectively. One sailing barque, the *Rendova,* figures in the returns; one large motor vessel, the *Scout,* at Troon; and one railway ferry, the *Lucia,* at Whiteinch.

Only one merchant sailing ship! And thirty years ago there were 104 firms in Glasgow and Greenock registered as owners of iron sailing ships. Of these, 74 have disappeared, 13 are still sailing-ship owners, 8 have abandoned sailing tonnage for steam, 6 are now in other lines of business, and three now own steam as well as sail tonnage. To these have to be added 28 new firms, the total now standing at 41. In 1887 the sail tonnage owned in Glasgow aggregated 411,970 tons; to-day it is only 316,102 tons. In 1877 the average size of each sailing fleet was 3,960 tons, against 7,710 to-day; while the average size of the ships was 1,135 tons, against 1,860 this year.

There are on the Clyde about fifty shipbuilding firms, ranging from the builders of small launches and yachts up to builders of great liners and mighty cruisers and battleships. The only type of vessel not represented in 1907 on the Clyde is the large turret, trunk or cantilever steamer, which figures so largely in the work of the northeast of England yards. Variety of work has always been a feature of Clyde shipbuilding, and the district therefore often keeps busy after a falling off in other districts. A "slump" in cargo steamers hits all the northeast coast hard, but the many special vessels on the Clyde—liners, warships, dredgers, vessels for export in parts, and yachts—keep the yards here employed for a considerable time after they have ceased to book cargo steamers. This is why the 1907 tonnage exceeds even that of 1906, though the year closes with very poor prospects. There has never been a year in which so many small vessels have been built on the river; trawlers and steam drifters for deep-sea fishing; launches, barges, lighters, pontoons, steam ferries, shallow-draft steamers for river services abroad, tugs and tenders for service at foreign ports, and steamers built in section, shipped to other countries, and then transported and rebuilt on inland lakes.

The year closed with many workmen idle and many yards empty, particularly yards where first-class liners are built, and yards which depend on "tramp" steamers. The builders who do miscellaneous work are partly able to keep their staffs together, but most of the big yards have paid off large numbers of men each week for some months back. There is no demand for cargo steamers, and builders are prevented by the high price of material and labor from tendering low enough to obtain orders. Many of the orders booked recently have been at below cost prices, taken to keep establishments going in hope of better times. When wages come down after the

* International Marine Engineering, May, 1907, p. 200.
† January, 1908, p. 42.
‡ January, 1908, p. 1.
** International Marine Engineering, August, 1906, p. 291; May, 1907, p. 202; June, 1907, p. 230; September, 1907, p. 382; October, 1907, p. 389.

† October, 1907, p. 424.

new year, if there is also a further reduction in the price of shipbuilding materials, the position may improve a little; but the situation is doubtful, until the trade of the world recovers and there is more money for investment in new ships. The outlook is bad, and it is practically certain that the tonnage output for 1908 will show a very considerable decrease. The cause is said to be, partially at least, overproduction during the past three years.

It is evident that the dullness prevalent all over this district will continue well into this year. There is an exceptionally large number of vacant berths, and the total tonnage on hand is lower than it has been for a long time, and is very irregularly distributed. A few yards are well employed, while others are practically and some absolutely idle. The Fairfield and Clydebank Companies are completing the battle cruisers *Indomitable* and *Inflexible;* but on the stocks at Fairfield there are only two small steamers (one for the Canadian Pacific Railway Company, and one for service in the East), and at Clydebank the shipyard berths are all vacant. At Dalmuir (Beardmore's) the only vessel in course of construction is the last of four steamers for the Pacific Steam Navigation Company. These three yards employ, normally, from 15,000 to 20,000 workers, but at present they are finding work for only a few hundred.

The London & Glasgow Shipbuilding Company has been idle for a considerable time, and D. & W. Henderson & Co., Partick, who usually have their yard well filled, have only two vessels on the stocks, one of them for the Anchor Line's Eastern trade. John Reid & Co., Whiteinch, have very little work on hand, while Napier & Miller have only an oil-tanker for the Anglo-American Oil Company and a cargo steamer for home owners. At Renfrew, Lobnitz & Co. have three vessels on the stocks, one a large dredger and the others smaller vessels; while Simons & Co. have also three vessels in course of construction. Charles Connell & Co. have six steamers at different stages of construction; Barclay, Curle & Co., three large vessels; and Alex. Stephen & Sons, who have just launched the new Allan liner *Hesperian*, have several vessels on the stocks and on order. Yarrow & Co. have four torpedo boats building, in their new yard at Scotstoun, for the Brazilian government, and six others to lay down, and they are also building two motor boats for the Austrian government. A. & J. Inglis, Pointhouse, are completing the new yacht for King Edward, and building a large steam yacht for an American owner, a steamer for G. & J. Burns, and a railway ferry for the Entre Rios Railway Company, similar to the *Lucia Carbo*, completed last year. They have also two large paddle steamers to lay down for South American owners. Mackie & Thomson have nine fishery steamers on the stocks, for North of Scotland owners.

Dumbarton has had steady work for about ten years, but at present fares no better than the other parts of the river. In Denny & Brothers' yard the work on hand includes two torpedo-boat destroyers for the British government, a large trading steamer, and a variety of light-draft vessels for shipment abroad. McMillan & Co. have two large cargo steamers on the stocks. At Greenock the condition of trade is unsatisfactory, and in only one of the yards are the prospects good. This is Caird & Co.'s, where three vessels are building for the Peninsular & Oriental Company—two large passenger liners and an express mail boat for the Bombay and Aden service. These vessels should keep the yard employed for a year. Scott's Shipbuilding & Engineering Company has on the stocks only one vessel (a twin-screw yacht). The Greenock & Grangemouth Shipbuilding Company, after launching a vessel of 3,500 tons, has only an oil-steamer contract, secured recently.

While one or two of the Port-Glasgow firms have a good amount of work, the outlook all around is anything but bright. D. J. Dunlop & Co. have one vessel in course of construction, while an order for another has been secured from a Hong Kong firm. In the yard of Russell & Co. there are seven large steamers nearing completion. William Hamilton & Co. have one steamer almost ready and another in progress, while the keel will shortly be laid of a vessel for Amsterdam owners. Murdoch & Murray have one steamer for a Glasgow firm. Ferguson Brothers, who have had a busy year, have still four—a dredger-tender for the Thames Conservancy Board, a ferryboat for the Clyde Navigation Trust, a bucket-dredger for India, and a tug for service on the West coast of Africa. In the yard of the Clyde Shipbuilding & Engineering Company there is one vessel under construction, and A. Rodger & Co. have only one, which is ready for launching. In Paisley, John Fullerton & Co. are practically idle, but Fleming & Ferguson start the year with three small vessels under construction. Bow, McLachlan & Co. will also have a fairly good year. The Ailsa Shipbuilding Co. has a steamer of about 2,000 tons building at Troon, and is constructing three steel barges for shipment to South America, and a small coasting steamer. The work at Ayr yard includes a steamer of 900 tons for British Columbia, a steamer of 475 tons for the Glasgow coasting trade, and six barges for Brazil. The Campbeltown Company is building two vessels of about 9,000 tons. The building of motor boats is coming to be an important industry, and quite a number of firms are now specializing in this type of craft. The total tonnage of new work on hand at the beginning of 1908 was 315,000 tons, as compared with 410,000 at the beginning of 1907.

Of the total tonnage built in the world during 1907, 60 percent was built in the United Kingdom; 42 percent was for owners in the United Kingdom and British colonies; 18 percent represented work done by British builders for foreign owners. In 1906 the work done in the United Kingdom for foreign owners was much less—11 per cent; and in that year the proportion of the world's tonnage produced by British yards was 66 percent. The output of the United Kingdom, with all warships and all merchant ships of less than 1,000 tons excluded, was a quarter of a million tons less than in 1906, although the tonnage built for foreign owners was 150,000 tons more. The increase in the foreign tonnage was due largely to the development of the emigrant trade between the Mediterranean and America. All the Italian ships built here were for this trade, as were the greater number of those built for Austria and several for France. French owners bought several vessels that were building for British owners, because native builders could not give quick enough delivery. South American firms have built largely in this country. The Lloyd Brazileiro, of Rio de Janeiro, was the principal customer from that quarter. The Tyne and the Wear both produced more tonnage for foreign owners than the Clyde. The extent of the Clyde total tonnage built for foreign account was 105,867 tons; that of the Tyne, 111,201 tons; that of the Wear, 112,522; and on the Tees, 78,841 tons. Germany produced 258,640 tons, and had built 46,555 tons in the United Kingdom. France produced 70,513 tons, and had built 48,613 tons in the United Kingdom. Japan produced 52,214 tons, and had built 12,790 tons in the United Kingdom.

In 1907, Britain launched six vessels of over 10,000 tons, as compared with three launched elsewhere; and of vessels between 8,000 and 10,000 tons launched twelve, as compared with seven launched elsewhere.

As to the work of the year, there was no *Lusitania* in 1907. The coasting and cross-channel steamer is a familiar product of the Clyde, and in size, arrangement, and structure has shown comparatively little variation for years, as their trade requirements have varied not so much in character as in quantity. There has, however, been an advance in the internal economy of these vessels in recent years, in removing obstructions in the holds and in special arrangements to dispense with

stanchions in the way of the hatchways. Every request of owners for provision of facilities for rapid handling of cargo has been quickly met. In the latest examples of these steamers there are no stanchions whatever, and no webs or other structural obstructions in holds or between decks. Improvements have also been carried out in the general design of the vessels of this type, which can now not only handle cargoes more rapidly and cheaply, but carry them more safely and more free from damage than in former years.

In the building of ocean cargo steamers there has been much development of recent years. The turret ship, which dates from 1892, is distinguished by its complete departure from previous standards of sea-going cargo steamships. The turret ship has no sheer, and the central turret erection makes it a self-trimmer, while the disposition of the material provides stiffness to resist both vertical and horizontal bending stresses. These ships are usually built with no deck below the turret deck. The ship is kept in shape by an open framework, at intervals of about 27 feet, consisting of two vertical and two horizontal members, so that if the continuation from the rounded base of the turret to the round-over of the side plating is part of the shell structure, they are single-deck ships. Their internal structure has recently been developed by leaving the holds free from cross-beams, and by combinations on the principle that the most economical disposition of material in a box-shaped girder should be that which places it chiefly on the external walls. Doxford & Sons, Sunderland, the patentees, have built 174 turrets, representing 663,701 tons.

The turret steamer stimulated builders and owners to other departures from conservative designs. There was a change of view as to the number of decks for a cargo steamer. A deck below the upper deck is desirable for dividing cargo and providing cattle accommodation; but in a steamer intended for the carriage of timber, grain, coal and bulk cargoes, such a deck obstructs the handling of self-trimming cargoes. Yet, the habit of the old-time two-decker and three-decker was constant, until wide-spaced strong beams began to be fitted in place of a lower deck. Later, demands of timber traders caused the realization of the fact that these beams could be left out if the strength of the framing was increased. The possibility of interfering with the second deck in a three-decker was not contemplated fifteen years ago, and it is only ten years since the change to one deck was made in the steamer *Lincluden*, built by Furness, Withy & Company, Ltd., Hartlepool. Single deckers of 28 feet depth are now well known. A development has also taken place in the simplification of vessels in which the depth is so great that subdivision is necessary in order to render possible the carriage of general cargo in the holds. The Glasgow-built steamer *City of London** has a depth so great that, in very recent days, she would have been regarded as impossible with less than two or three 'tween decks and a tier of hold beams. Such vessels are now constructed with only one 'tween deck space, 11 feet in height, and no beams below the second deck.

Other new developments are Harroway & Dixon's "cantilever" ship, in which a triangular corner of the top sides is cut off for water ballast; McGlashan's "double-skin" ship; Isherwood's longitudinally stiffened hull, and Burrell's "straight-back" steamer. The latest is the steamer *Thor*, 7,500 tons dead weight, built last year by Ropner, of Stockton, and classed with the British Corporation. She is built on Ropner's trunk principle (a turret without the rounded base or the round-over at the junction of the harbor deck and side plating), but the trunk has two walls on each side, between which are 500 tons of water. The engines are aft; there are no bulkheads between the machinery space and the fore peak; there are two hatchways, each over 100 feet in length and 28 feet in width, and the top structure is supported by strong webs in the holds, to the practical exclusion of cross-ties and stanchions. The tendency of the classification societies is to broader views, though endeavoring to insure strength, efficiency and the highest quality of workmanship in the vessels constructed under their supervision. They are now more disposed to aid structural designs in better directions, realizing that many of their former rules were founded upon obsolete practice. The shipbuider has thus advanced during recent years in the simplification of hull structures, through reduction of the number of its parts.

Though 1907 was the year of the ocean liner and of the fishery steamer, there have been improvements in other directions which promise to have more effect on the working of the world's mercantile marine. The tramp is the mainstay of the shipping industry, and anything which makes this type of vessel more easily handled and faster, without increasing expenses, is a benefit to the whole community. In the clear holds the early turrets had not very much advantage over ordinary steamers, but the newer turrets and trunks and Sir Raylton Dixon & Company's "cantilever" vessels are designed to present no obstacles whatever to the handling of cargo, having neither pillars nor beams to break the expanse of hold space, and having continuous hatchways all over the holds, and derricks commanding every place where cargo is stowed. The masts have disappeared and their places taken by an array of derricks. The engines are usually aft, and the vessels are large, hollow steel girders, into which cargo can be loaded, and from which it can be discharged with the minimum of labor and time. The clear-hold, self-trimming and self-loading and discharging steamer is the cargo steamer of the future.

Then as to motive power, the British torpedo destroyers have proved the efficiency of oil fuel and turbine machinery working in combination, but oil-burning boilers must be restricted to war vessels or to vessels trading between ports where oil is obtainable. As to steam propelling engines, there have been several reports of inventions to supersede the turbine, but these have been nearly all of the nature of reversing turbines, and in no case has a detailed description been published. The reversing turbine will come some day, but meantime nothing has superseded the plan of having two turbines on the same shaft—one ahead and the other astern. The internal combustion engine may displace, not only oil fuel and boilers of all kinds, but also both types of steam engine, but we have not yet got internal combustion engines for propelling ordinary vessels. The difficulty seems to be in the unreliability of cast iron and cast steel to withstand serious and quick changes of temperature. The oil motor is the only new type which has been tried in practice, and in the course of this year it will be tested in a passenger vessel which MacBrayne & Company have had built for their West Highland service. She uses Scottish crude shale oil, and if the system is a success it will inaugurate a new development in marine engineering. An electric ship, with turbines to drive high-speed electrical generators, supplying current to motors to drive the propellers, is said to be in preparation. She, or something like her, will arrive some day.

The Great Lakes Engineering Works, Detroit, Mich., launched, during the first week in February, two large freighters for service on the Great Lakes, the *Normania*, on Feb. 5, and the *M. A. Bradley*, on Feb. 8. The latter is 480 feet over all, 460 feet on the keel, with a beam of 52 feet and depth of 30 feet. Her deadweight carrying capacity will be about 8,300 tons. She is building for the Alva Steamship Company. The berth made vacant has been already taken by a new 10,000-ton steamer for bulk cargo service.

* International Marine Engineering, September, 1907, p. 345.

THE STEAM YACHT WINCHESTER.

This twin-screw yacht, built from the designs of Henry J. Gielow, New York, for Peter W. Rouss, of the New York Yacht Club, has a steel hull constructed by Robert Jacob, City Island, New York. The principal dimensions are: Length over all, 141 feet 6 inches; length on load waterline, 140 feet; width, extreme, 15 feet 6 inches; depth of hold amidships, 9 feet 9 inches, and 6 feet draft. The scantling is unusually heavy, giving great strength.

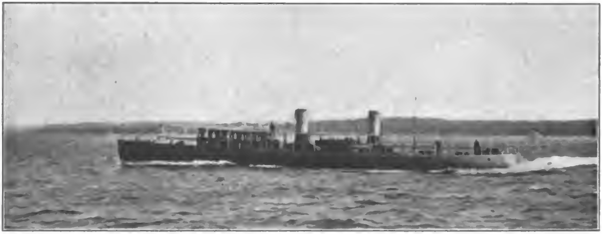
She was built in the best possible manner, and of a high quality of mild steel, the chemical tests of which showed not more than 0.06 percent of phosphorus, and not more than 0.04 percent of sulphur, and the material is of the best composition in other respects. In plates of No. 5 B. W. G. and heavier, the tensile strength is not less than 55,000 pounds, nor more than 60,000 pounds per square inch; plates lighter than No. 5 B. W. G. have a tensile strength of not less than 50,000 pounds per square inch. All plate material was tested, and gave an elongation of more than 25 percent in 8 inches. Test pieces cut from plates were bent over flat on themselves without sign of fracture,—in fact all the materials were thoroughly tested, and passed through a rigid inspection before being used. Every precaution was taken to make the craft safe, staunch and seaworthy.

The keel is of the flat plate type, with intercostal keelsons extending above the floors and connected with continuous angle-bars riveted back to back, the plates being stapled to the floors and keel plates with angle-bars. The frames are of angle-bars 2½ by 2 inches by 2.75 pounds per foot. They are placed square to the load waterline, and spaced 20 inches between centers, stiffened by deep floors with reverse bars, which extend up to the turn of the bilge. The foundation and floor system in the engine room is carefully worked out, and when running at full speed there is not the slightest evidence of motion or swaying of the engines,—so commonly noticeable in high-powered steam vessels. The plating is run in fair lines, and in and out strakes, all horizontal seams being lapped and vertical seams butted. The thickness of plating ranges from No. 4 to No. 7 B. W. G. There are five watertight bulkheads in the vessel, dividing her into six watertight compartments, so that she is practically non-sinkable.

The arrangement, briefly stated, is as follows: Forward is a mahogany deck house 22 feet in length, the forward end forming a dining saloon, with a seating capacity for fourteen persons; this has a buffet, with mirror and cabinet for silver. Abaft of the dining-room, on port side, is a butler's pantry, with refrigerator and ice-box, dresser, sink, lockers and racks and a dumb-waiter leading to the galley below. On the starboard side is the captain's stateroom, fitted with a berth, wardrobe, wash basin, desk and chart rack.

The quarters forward, below deck, for the crew are commodious and comfortably arranged, and the staterooms for officers are ample and pleasing. Then comes the galley, large, roomy and well ventilated, with large ice-box and refrigerator fitted in addition to the usual dressers, shelves, lockers, dish racks, etc. The machinery space comes next, and in order to deaden the sounds, keep the heat away from the living quarters forward and aft, and reduce the labor of firing to a minimum, athwartship coal bunkers are fitted.

Abaft of the machinery space is a dressing room extending the full width of the vessel, with toilet and bath with tiled floor. Aft of this are two large connecting staterooms with wide berths, sofas, bureaus, etc., complete. Then comes a large cabin extending the full width of the vessel, arranged with sofas, sideboards, cabinets and bookcases. Still further aft on the port side is a toilet and bathroom, and on the starboard side is a stateroom. The sofas, berths, bureaus and sideboards are of selected mahogany, polished, and the rest of interior finish is in white enamel with line gilding.

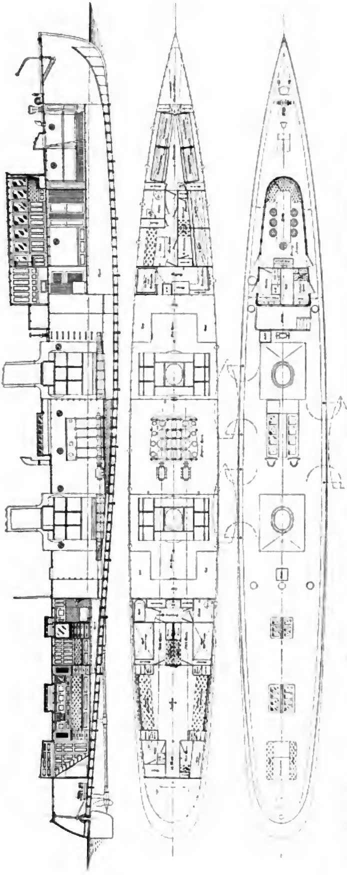


THE STEEL STEAM YACHT WINCHESTER, RUNNING AT HIGH SPEED IN LONG ISLAND SOUND.

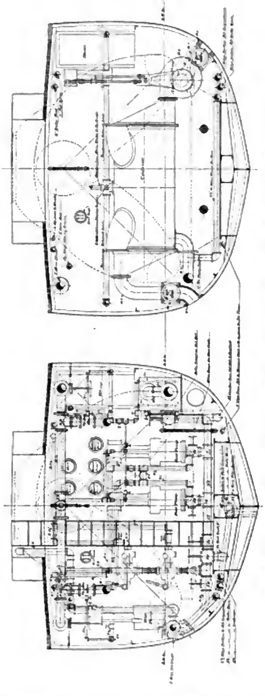
Particular attention has been given to the machinery, and nothing has been spared to have it first class, and to secure the smoothest running. The two main engines are of the triple expansion type, having four cylinders to secure perfect balance. The high-pressure cylinder of each engine is 12 inches, the intermediate 18 inches, and the two low-pressure cylinders each 20 inches in diameter; all with a common stroke of piston of 15 inches. Much care was given to balancing these engines, both in mechanical parts as well as valve adjustment, and the results have been exceedingly satisfactory, for when running at 350 revolutions or more there is practically no vibration.

Steam is supplied by two watertube boilers, built for a working pressure of 270 pounds to the square inch, with a combined grate area of 106 square feet and a heating surface of 4,600 square feet (ratio 43.4 to 1). Each boiler is placed in a separate compartment, with its own fire room, and is so arranged that the gage glass is in sight of the engineer, who controls the water supply, blowers, etc. Each fire room and the steam connections are so arranged that either one of the boilers may be used entirely independently of the other. The surface condenser was especially designed for this yacht, and there is no difficulty in maintaining a vacuum of 25 inches. The circulating pump is centrifugal. A complete set of pumps, injectors, bilge ejectors, etc., is supplied and installed.

No official trial trip was made, but during the engineer's trial

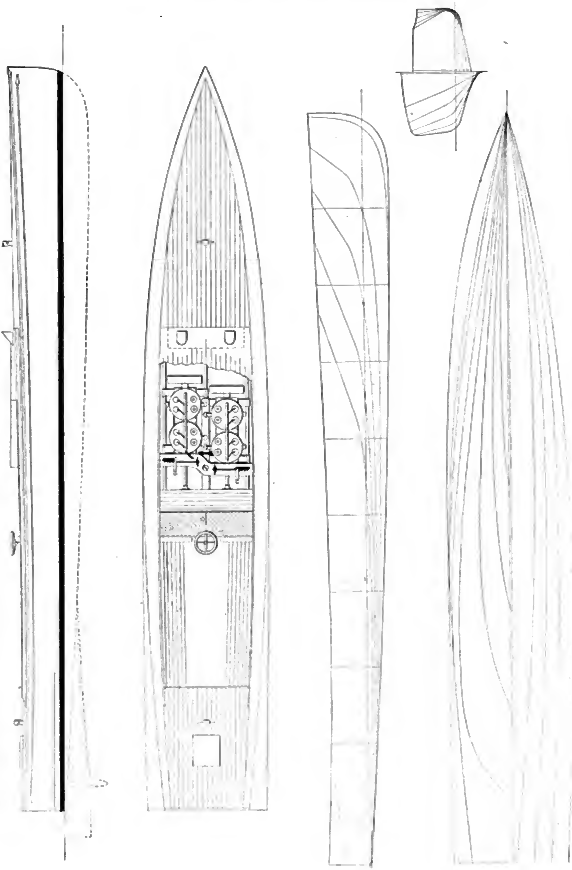


INBOARD PROFILE AND LOWER AND MAIN DECK PLANS OF THE 140-FOOT STEEL STEAM YACHT WINCHESTER, DESIGNED BY HENRY J. GIELOW.



TWO SECTIONS THROUGH THE ENGINE ROOM, SHOWING PIPING PLAN FOR THE PUMPS, CONDENSER AND OTHER AUXILIARIES.

the owner was aboard, and as everything worked perfectly, he accepted the boat upon that showing, without waiting for a formal trial trip. On this trial, a speed of 19.5 knots was maintained for 4½ hours. No maximum speed run was made, but several runs made subsequently, when in commission, showed the boat capable of maintaining a speed of over 25 statute miles per hour.



OUTBOARD PROFILE, DECK PLAN, LINES, BUTTOCKS AND BODY PLAN OF THE SPEED BOAT IRENE, BUILT BY JOHN S. SHEPPARD, ESSINGTON, PA.

High-Speed Motor Boats for Pleasure Use.*

BY HENRY R. SUTPHEN.

Several manufacturers are now prepared to deliver from stock, or upon short notice, 18 and 25-mile motor boats equipped with gasoline marine engines for pleasure use. About four years ago the high-speed gasoline launch was first introduced into America. The rates of speed then obtained were remarkable in comparison with the average launch of that day. The first boats produced were designed particularly for racing, and developed speeds of from 24 to 27 statute miles per hour, the hulls being of light construction and the engines of minimum weight. From the experience in building the racing launch, the high-speed pleasure boat has been developed, which fills the demand that has long existed for a safe, seaworthy boat that could cover distances over the water in the shortest possible time.

A photograph is published of the *Irene* at full speed, with amidships section showing scantlings and planking employed. In comparison with a typical racing boat, the *Irene* could be classed more as a pleasure launch, the hull being of medium weight with wide beam and high freeboard. Total length of boat, 39 feet 8½ inches; beam, 6 feet 6 inches; draft at propeller wheel, 3 feet; freeboard amidships, 26½ inches. Large seating capacity is provided aft to accommodate eight to ten passengers, the general lines showing a fine entrance at the bow; amidships section as shown in plan; with a broad, flat stern, the latter materially assisting in holding the boat on an even keel when running at high speed.

The *Irene* is one of the first high-speed motor boats in this country to be equipped with twin screws, which give some advantage over the single screw for high-speed service. The side thrust of the single propeller is of considerable moment, and in some boats this is so great as to cause a decided list when running at high speed. With twin screws this is entirely obviated, and while the total weight of the power equipment is a little more, the steady operation of the boat in the seaway and while turning at full speed is of great advantage.

THE MOTOR BOAT IRENE RUNNING AT FULL SPEED ON THE HUDSON RIVER, BOUND NORTH.

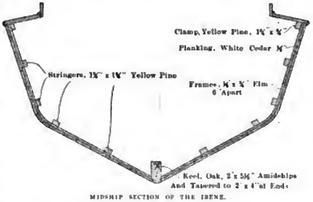
On Sept. 28 the motor boat *Irene* was run six times over the government nautical mile course on the Hudson river, three with the tide and three against. The time for the various runs is given in the following table:

Down..........2.17 = 26 277					
	25 904				
Up.............2.21 = 25 532		25 904			
	25 904		25 86		
Down...... ...2 17 = 26 277		25 815		25 803	
	25 726		25 747		25 725
Up....... ...2.23 = 25 175		25 678		25 647	
	25 631		25 548		
Down.. ......2.18 = 26 087		25.418			
	25 205				
Up...... ......2.28 = 24 324					

25 725 nautical miles = 29 622 statute miles.

This is the highest speed that has been recorded in the trials held by the Motor Boat Club of America, which are yearly events, over the government course on the Hudson river. No special preparation had been made for the *Irene's* speed trials, the boat having on board during the trial 180 gallons of gasoline (petrol), five men and full equipment, the total weight being about 5,600 pounds.

The *Irene* was designed and built by John S. Sheppard, of Essington, Pa., who states that in racing trim the total displacement of the boat figures a little less than 25 pounds per horsepower. The two engines installed were built by the Chadwick Engineering Works, Philadelphia, and are each rated at 100 horsepower, each engine being of four cylinders, 8-inch bore by 7-inch stroke, turning 850 revolutions per minute. The propellers are of three-blade, 24-inch diameter, 44-inch pitch (pitch ratio 1.833).



MIDSHIP SECTION OF THE IRENE.

On account of the initial cost, cost of operation and maintenance, few desire for pleasure purposes a boat of 200 horsepower, and I therefore present photographs and drawings of high-speed motor boats of moderate power, which are the general type now built for pleasure use.

The 33-foot *Elco* express boat,* 5 feet 6-inch beam, is of light but substantial construction, equipped with a 4-cylinder, 40-horsepower gasoline engine of the auto-marine type, and

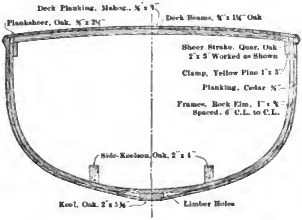
* Read before the Society of Naval Architects and Marine Engineers, New York, Nov. 21, 1907.

* Electric Launch Company, Bayonne, N. J.

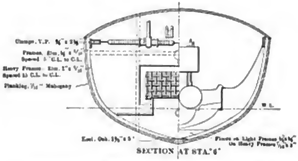
THIRTY-THREE-FOOT ELCO EXPRESS OPEN MOTOR BOAT ORIOLE.

develops a maximum speed of 20.4 statute miles an hour, as much as is required by the average owner. A section illustrates the scantlings employed in hull construction, the elevation and plan showing the general arrangement of power equipment and seating space. The weight of hull is 1,050 pounds, being in proportion to weight of power equipment (1,010 pounds); seating capacity, eight to ten passengers. This type of boat has proved very seaworthy, reliable in operation, and easily controlled.

Illustrations are also given of a 40-foot *Elco* express boat, 5 feet 6-inch beam, details of construction being shown in the amidships section. This boat is equipped with a 4-cylinder, 70-horsepower engine and develops a speed of 24.4 statute miles per hour. The general arrangement is similar to the 33-foot boat, and is the plan usually employed in this type of launch. The engine is located forward under removable hood,



MIDSHIP SECTION OF 40-FOOT ELCO EXPRESS BOAT.

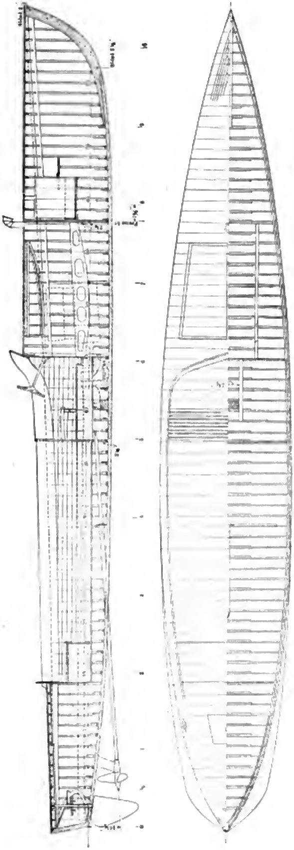


MIDSHIP SECTION OF 10-METER ELCO EXPRESS BOAT ORIOLE.

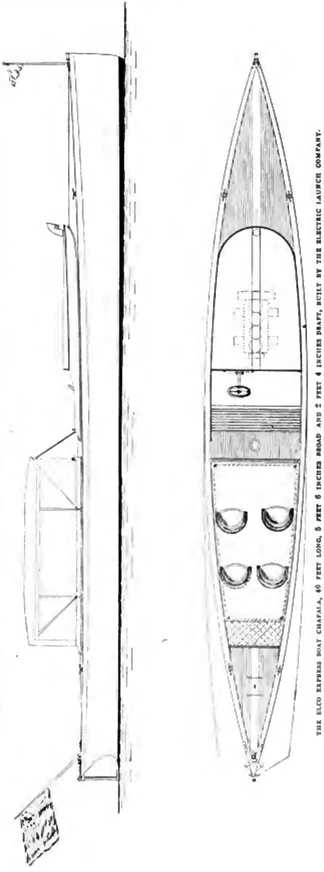
separated from the operator and passengers, the controlling levers being placed on the bulkhead aft of the engine, at which point the steering wheel is located, enabling one man to operate the boat, who oftentimes is the owner. To give the passengers protection from flying waters, headwinds and rain, a glass wind shield and folding hood are provided. This type of boat, it is claimed, will serve one on the water as the automobile does on land.

While the principal development of the high-speed launch has been in the open type of boat, attention has lately been given to the cabin launch, affording still further protection, comforts and carrying capacity combined with high speed. A photograph of the *Carlotta* illustrates a 40-foot by 8-foot beam cabin launch of unique design. The motor is placed forward, protected with hinging hood, controlling levers and steering wheel located in engine cockpit. The boat is handled and the engine controlled by one man; an open space covered by the cabin roof adjoins the engine compartment, separated by a glass wind shield; with commodious cabin amidships inclosed by plate glass windows, and with buffet and toilet compartments. The amidships section shows the scantlings and

FORTY-FOOT ELCO EXPRESS CABIN MOTOR BOAT CARLOTTA.



INBOARD PROFILE AND CONSTRUCTION PLAN OF THE 10-METER (33-FOOT) ELCO EXPRESS BOAT ORIOLE, BUILT BY THE ELECTRIC LAUNCH COMPANY.



THE ELCO EXPRESS BOAT CHAPALA, 40 FEET LONG, 5 FEET 6 INCHES BROAD AND 2 FEET 4 INCHES DRAFT, BUILT BY THE ELECTRIC LAUNCH COMPANY.

details of construction, which are light, but found to be substantial. The boat is equipped with a 6-cylinder, 75-horsepower engine, with which power a speed of 18.85 statute miles an hour has been obtained. The photograph was taken when the boat was running at full speed.

The possibilities of further development of the high-speed motor boat for pleasure use are limited only in details of hull and engine construction, the aim being to design and build boats that best conform to the high-speed gasoline marine engine, which has made possible this new type of power boat.

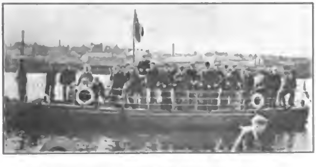
Clyde-Built Motor Launches.

We present photographs of two motor launches recently designed by Mr. C. L. Ewen, naval architect, Glasgow.

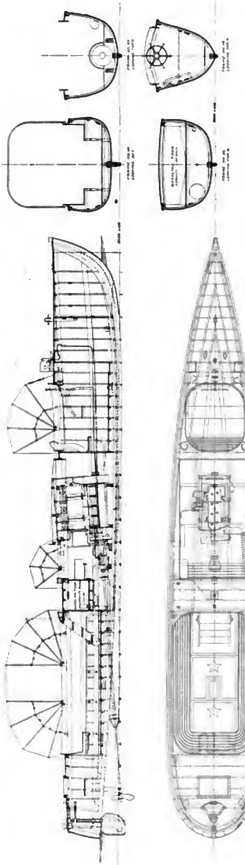
The *Brandane* was designed and constructed for the Marquess of Bute. The length is 42 feet, beam 8 feet, draft aft 3 feet. She is an able sea-going launch, and is used principally by Lord Bute for fishing and trawling purposes. The engine is a 22 brake horsepower Mitcham "F. & B." triple-cylinder two-stroke cycle petrol (gasoline) motor, which turns up a 32-inch three-bladed propeller at 500 revolutions per minute. The consumption of petrol is small, averaging only 2 gallons per hour. The speed is about 10 knots.

THE MOTOR LAUNCH BRANDANE.

The *Border Chief* was designed and constructed for Spowart Brothers. Her length is 40 feet, beam 10 feet, draft 2 feet 6 inches aft. She is a ferryboat with a Board of Trade certificate for fifty-four passengers, and is used on the River Tweed between Berwick and Spittal. In four months she carried 60,000 passengers, and is giving great satisfaction. The power in an 11 brake horsepower Mitcham "F. & B." double-cylinder two-stroke cycle petrol motor, which gives a speed of about 7 knots.



THE MOTOR FERRY BOAT BORDER CHIEF, WITH HEAVY LOAD.



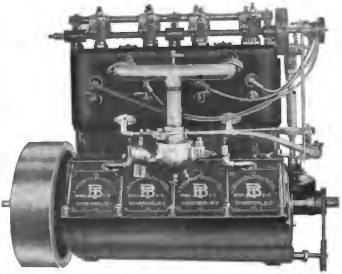
INBOARD PROFILE, PLAN AND TRANSVERSE SECTIONS OF MOTOR-PROPELLED ADMIRAL'S BARGE ATTACHED TO THE FLAGSHIP CONNECTICUT OF THE AMERICAN PACIFIC FLEET.

A Rear Admiral's Motor Barge.

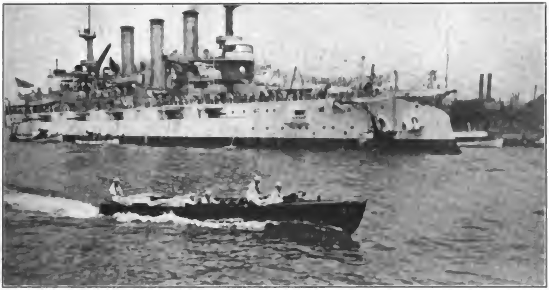
The photograph and drawings illustrate a 40-foot gasoline (petrol) barge, built at the Norfolk navy yard for the use of the commander-in-chief of the North Atlantic fleet of the United States navy. This barge, as tender to the flagship *Connecticut*, is now on its way to the Pacific in connection with the cruise of the squadron of battleships.

The boat is 40 feet in length over all, 38 feet 6 inches in length on the waterline, 5 feet 9 inches maximum beam on the waterline, and it has a maximum draft of hull forward of 17 inches. The displacement in normal running condition, with five men on board, is about 6,500 pounds. The motor is a Brownell-Trebert four-cylinder, four-cycle, and is rated at 75-brake horsepower at about 850 revolutions per minute. The highest revolutions obtained on trial were 771, which gave a corrected speed of 19.28 statute miles per hour. The propeller was not, however, a very efficient one, the apparent slip, which in a boat of this type should not be very different from the real slip, being only 14.8 percent with a pitch ratio of 1.1.

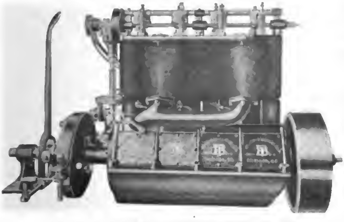
The lines of this boat are very fine, and the bow was made of a shape to overcome the trouble from flying spray. The result is a very dry boat, but the form does not produce quite as good a sea boat as if there were considerably more buoyancy



THE FOUR-CYLINDER 80-HORSEPOWER MOTOR, INTAKE SIDE.



THE MOTOR-PROPELLED BARGE OF REAR ADMIRAL EVANS. BATTLESHIP CONNECTICUT IN BACKGROUND.



THE FOUR-CYLINDER 80-HORSEPOWER MOTOR, EXHAUST SIDE.

below water forward. The boat is of the dolphin model, and is said to ship no water, even in a considerable sea. The model is such that she cuts the water like a wedge, and with an almost total absence of spray going on board.

The engine, which was built by the F. A. Brownell Motor Company, Rochester, N. Y., has four cylinders, 6¾ inches in diameter with a 6-inch stroke. There are but two in-take and two exhaust pipes for the four cylinders, the latter pipes being carried downward to the lower part of the cylinders, where connection is made with the manifold. The engine weighs complete 1,500 pounds, and drives a propeller 24 inches in diameter and 26½ inches in pitch, through a propeller shaft of 1¾ inches. The extreme length of the engine, from the end of front bearing to the outside face of fly-wheel, is 48 inches; the length over cylinders is 34 inches; the height from center of crank shaft to clear everything on top of the motor is 31 inches; the width over the base is 20 inches; the width between keelsons is 22 inches; the distance from the front

face of fly-wheel to the center of the knuckle joint on the reverse gear is 16 inches; the diameter of the fly-wheel is 20 inches.

Just aft of the engine room is an athwartship fuel tank, with a capacity for 93 gallons of gasoline, and fitted with a strainer in the pipe supplying fuel to the engine. Counterbalance slings are attached for hoisting. with hooks aft, amidships and forward, and also side hooks amidships. There are four canopies for protection in wet weather, two being over the cockpit aft, one over the steering position forward, and the fourth, which is a small one. is over the rear end of the engine, and protects the engineer. There is a speaking tube from the stern sheets to the steering cockpit, for the transmission of orders. The crew consists of five men—coxswain, seaman, engineer, machinist and ordinary seaman.

The barge is divided into five compartments by four athwartship bulkheads, located respectively on frames 5, 17, 31 and 44. The first is the collision bulkhead; the compartment aft of this contains the steering cockpit and space for stores; the third compartment contains the engine and accessories as well as the fuel tank; the fourth compartment is the hooded cockpit, while the after compartment may be used for stores, and contains also the steering quadrant operating the balanced rudder. Near the end of this compartment the exhaust is discharged above the water on the starboard side, after having passed through a muffler (silencer) located in the after end of the engine compartment. The cockpit has a seat running around the two long sides and the after end, and is entered by means of a short stair from the forward end. giving upon the top of the gasoline tank, which is built over as a flush deck.

SOME OBSERVATIONS ON MOTOR-PROPELLED VESSELS AND NOTES ON THE BERMUDA RACE.*

BY WILLIAM B. STEARNS.

In presenting this paper my chief object is to promote discussion of a subject which does not seem to secure from most naval architects the consideration that its importance warrants. In spite of the great progress already made, the traditions of steam are still so strong with most of the profession that any suggestion looking toward the application of internal combustion motors to anything except small vessels is treated as fanciful. While I would not for a moment advocate attempting to turn out a motor-driven battleship or express steamer at present, it seems to me that the time has come when we cannot longer neglect such a possibility of developing a prime mover more economical of space, weight and fuel, as seems to be offered by the explosive motor.

Stationary motors, giving upward of 2,000 horsepower per cylinder, are in successful operation to-day, and in these machines the thermal efficiency is well in advance of results which are obtained with the best steam plants. If an assembly having six of these cylinders could be devised for marine use, we should have a unit of 12,000 horsepower, and four shafts would make 48,000 horsepower available for a single vessel.

If, by the process of evolution, the weight of such engines can be reduced to any such extent as has been the case in the smaller machines, we shall have a power plant beyond the wildest dreams of the steam engineer. Naturally, we cannot expect to attain such results in a month or a year, but it is putting a very low value on the human intelligence to suppose that the difficulties to be met with in modifying and adapting existing forms so as to make such a machine successful are insuperable. It has taken steam a century to reach the stage where its development seems to be approaching finality. Is it not absurd to suppose, as several members of the profession have seriously suggested in my presence within a short time, that the gas engine is not capable of much greater development than it now shows? I remember in 1895 making a trip in, perhaps, the first motor boat built on the Clyde. The engine was a 10 or 12-horsepower Daimler, and on a three days' trip from Gourock to Oban we had an almost endless succession of difficulties, in spite of the fact that one of the best engineers of the Daimler Company accompanied us. The machine in every detail was crude, heavy and ill-adapted to its purpose. Yet in the short space of twelve years we have seen the principles embodied in that clumsy contrivance work a revolution in the propulsion of small vessels. Comparing the progress of the gas engine in its early years with that of steam, we are surely warranted in the belief that ten years has not seen its possibilities worked out. On the doctrine of chances alone we are safe in such an assumption. Looked at from this point of view, the 12,000-horsepower unit does not seem like such a stretch of the imagination.

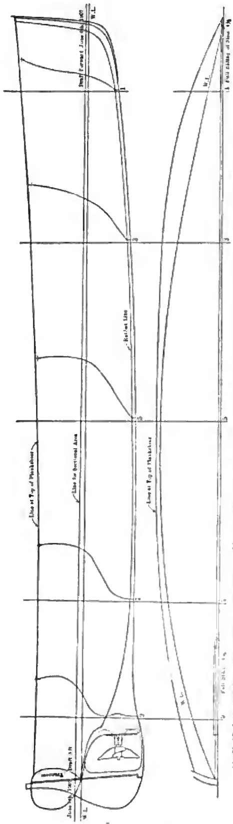
It is not within the scope of this paper to consider the motor itself from any point of view except that of the naval architect. I have recorded above, however, my views as to the importance of the subject, and it is with the idea that in such matters even small contributions are worth while that I venture to set forth here a few observations on certain aspects of the motor-propelled vessel as a whole. These observations have been made on comparatively small vessels, but I think the principles involved will apply equally well to larger ones. and it is from the lessons learned in small craft that we shall gain the experience necessary to make larger ones successful.

There are several details which occur to me wherein I believe the general treatment of the design of motor-propelled vessels must differ from that for steamers. The reason for this is that, except in vessels designed for weight carrying, or for craft of very high speed, the designer of the motor vessel is troubled to know how to get rid of the excessive buoyancy, quickness of motion, and general liveliness which result from the lightness of the propelling machinery and fuel. On a given length a fairly liberal beam is usually necessary to provide the accommodations required by most owners. Sufficient displacement is obtained with a very shoal body, and unless the weights are distributed in such a way as to offset it, there is a strong probability that the vessel will be very uncomfortable on account of quick rolling. This can be reduced, to a certain extent, by keeping down the area of the loadwater plane, and placing some of the weight fairly high. My experience in the Bermuda race, however, leads me to believe that valuable results may be obtained by further manipulation of the weights in a way which is usually fairly easy to accomplish. To make intelligible a comparison of their performances I will describe briefly the two boats which made the run.

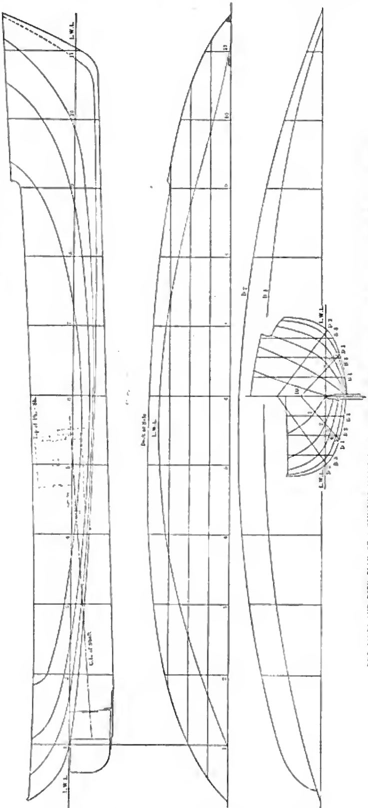
The two boats were of utterly different type. *Ailsa Craig*, the winner, looks above the water like a handsome miniature ocean liner. She is narrow, high-sided, and with a very deep V section has a form of almost no initial stability. She is 60 feet long, approximately 10 feet wide, with a total displacement of something over 40,000 pounds. With her slack section, the depth from waterline to rabbet is very considerable. All her weights are carried low. Under the cabin floor are stowed about 8,000 pounds of lead ballast. Her fuel tanks, which, with their contents, weigh about as much more, are also stowed as near the bottom of the boat as they can be carried. The center of gravity of the engine is probably considerably below the waterline, and with the exception of a couple of boats carried on deck, and one stout mast, there was in the race practically no top weight. She is fitted with bilge keels, but I am uncertain as to their dimensions.

The other competitor, *Idaho*, of which I had the good fortune to be in command, is almost the antithesis of her rival. She is 56 feet on the waterline and 12 feet 9 inches in breadth.

* Read before the Society of Naval Architects and Marine Engineers, New York, Nov. 21, 1907.



LINES OF THE MOTOR YACHT AILSA CRAIG: LENGTH, 59 FEET 10 INCHES OVER ALL; 59 FEET ON WATERLINE; EXTREME BEAM, 10 FEET 1 INCH; DRAFT OF HULL, 4 FEET.



THE LINES AND BODY PLAN OF A CRUISING MOTOR YACHT INTENDED FOR DEEP SEA SERVICE, WITH ENGINE COCKPIT AMIDSHIPS.

Her displacement in racing trim—that is to say, with 5,000 to 6,000 pounds of additional weight in the form of extra fuel, tanks, stores, etc.—is about 28,000 pounds. The depth from waterline to rabbet is 20 inches in normal trim, or only a little over one-third the corresponding depth of the other boat. The draft was limited to 3 feet 3 inches, and with a 25-horsepower Standard engine a speed was acquired of 11½ statute miles per hour. She was not, like *Ailsa Craig*, designed especially for

the race, but for a comfortable semi-cruiser. This resulted in a lightly constructed craft of excessive stability.

When the race was announced, and it was decided to enter the *Idaho*, it became a question of how to distribute the weight of extra fuel and stores to make her as little uncomfortable as possible in a seaway. The extra fuel, weighing with the tanks about 3,000 pounds, was finally placed in two long steel cylinders secured to the cockpit deck, as close to each side of the boat as we could get them. Nearly half the diameter of these tanks was above the gunwale. The rest of the cockpit space was then strongly decked over and made watertight with canvas. Between this temporary deck and the permanent deck of the cockpit we stowed reserve stores which, with the other supplies, made 2,000 to 3,000 pounds of weight at an average height of about 24 inches above the waterline. The center of gravity of the engine was roughly about on the waterline. The only low weight was that of the fresh water, weighing about 1,200 pounds, of which the center of gravity was some 10 inches below the waterline. In normal condition the metacentric height was about 5 feet. In trim for the race it was about 2 feet 6 inches.

No opportunity for a test was afforded until the second day of the race, when in the middle of the Gulf Stream a stiff northwest breeze began to raise a sea sufficient to cause a good deal of motion. All on board were most agreeably surprised at the result, but it was not until the return trip that we had a chance to compare *Idaho's* performance with that of *Ailsa Craig*. Coming home, the two boats made 350 miles of the run in company. In a very moderate seaway, *Ailsa Craig* rolled almost without intermission from 20 degrees to certainly not less than 40 degrees. On the *Idaho* I had fastened to the binnacle an improvised clinometer made of a semi-circularly bent tube containing colored alcohol and an air bubble. With a scale of degrees this enabled me to observe with fair accuracy the amplitude of her worst rolling. The heaviest roll observed was 23 degrees from the perpendicular, during a 35-knot quartering breeze. The sea at this time was quite heavy and very short. The period of rolling was not accurately observed, but the easiness of the *Idaho's* motions may be judged from the fact that when the sea was the roughest a quart milk bottle would almost but not quite stand on end without capsizing. After the passage of a series of steep waves, the boat would quiet down and for several minutes would run along very smoothly. It seems to me that this performance cannot be entirely accounted for by the amount of top weight carried, and I believe the dynamic effect of the two fuel tanks spread so far apart must have had an important part in making her so easy. I think this all goes to show that shoal-bodied boats can be made comfortable in a seaway, and I believe it is much more advisable to depend for the solution of the problem on the principles used on the *Idaho*, rather than to resort to the use of ballast, or bilge keels, which were certainly ineffective on the *Ailsa Craig*.

While on the subject of hull design, it may be interesting to speak of the surprising dryness and general seaworthy qualities of vessels of the type of the *Idaho*. Unfortunately, in the Bermuda race we had practically no opportunity to try the boats against a head sea. Both during the race and on the return trip all the strong breezes experienced came from abaft the beam, but on several other occasions I have been in craft of this sort in comparatively rough water, and have found them astonishingly good sea boats. If anything, the tendency is to recover too quickly after plunging into the sea. This is due, of course, to the extremely high proportion of reserve buoyancy to displacement, and results in one fault—a tendency to pound. On account of this, I do not think it is always an objection to put a certain amount of weight near the ends, on the same principle that I advocate spreading weights transversely. Also, I believe that the lines both forward and aft, but especially forward, of a light displacement motor-driven vessel, should be kept considerably finer than would be found necessary on a steamer of the same size. A comparatively minor matter, to cite another point of difference, is the rudder. I believe a motor vessel will generally require a larger rudder than a steamer. We found on the *Idaho* that it was difficult to meet her with sufficient quickness to avoid considerable deviation from the course when running before a sea, even with a rather large rudder area for her size. I think there are many other even more important points of difference which must be considered in the design of motor yachts, and, until we have acquired considerably more experience than at present, the commonly accepted ideas will have to be modified very frequently.

On most motor yachts, even of considerable size, owners usually desire that the engine room shall be in more or less direct communication with the rest of the vessel, although it would require only a small sacrifice of space to isolate it completely. I believe the advantages to be gained from making it a rule to do this in any yachts or other vessels of sufficient size would much more than counterbalance the sacrifice.

In a large motor yacht which is being designed by my firm for one of our clients at the time of preparing this paper, I have adopted some details of engine room arrangement which I have never seen used before on a motor yacht, but which I believe have many features to recommend them. The engine room is situated amidships, and at each end is a strong watertight bulkhead. The engine hatch is a section of the deck, so arranged that after the machinery is in place the hatch can be calked down and made tight. The tanks are situated in watertight compartments at each side of the engine room, and as the vessel is to be of wood, I propose to sheath the under side of the deck, the engine room side of the tank compartments, and the transverse bulkheads, with a thin sheet of asbestos and galvanized sheet iron. The companionway is conveniently situated, and so arranged that it can be readily closed. No other openings into the engine space are provided for, except an in-take and up-take for ventilation. An electric blower will be situated in the up-take, which will draw the air from under a grating in the engine room floor. The bottom of the boat will be cemented, so that in case of any leakage the flow will all be to a point under this grating and near the ventilator up-take.

All piping, wiring and shafts are to pass through the bulkheads in tight conduits or glands. Close to the under side of the deck I propose to place a contrivance made on the principle of the ordinary fire extinguisher; that is to say, there will be a tank containing a solution of bicarbonate of soda, and a flask of sulphuric acid will be arranged so that a blow on a plunger from on deck will break the flask, or spill the acid into the bicarbonate of soda solution. A pipe, or set of pipes, led from the bottom of the tank above the level of the liquid, will serve as the nozzle of the fire extinguisher. In case of fire, the engineer, after making his escape, could strike the plunger, close the hatch and ventilator openings, and the carbonic acid gas generated would quickly smother the flames. With an arrangement of this sort, it is difficult to conceive of a fire which would permanently disable the engines or seriously injure the vessel, and, as long as the blower was in operation, conditions could hardly arise which could lead to an explosion of any violence.

Only by using such precautions do I believe it safe to send to sea vessels containing large quantities of gasoline (petrol) for fuel, but in addition to the great feature of practically absolute safety this isolation of the engine room has many other advantages. The combustion of all hydrocarbon fuels results in the generation of a certain amount of carbon monoxide gas, which is a cumulative poison to the system and, when a sufficient quantity has been taken into the lungs, is the main

cause of the state which is popularly termed "gasified." No internal combustion engine of which I know is proof against a certain amount of leakage of these products of combustion past the pistons, and all of us who have had experience with ill-ventilated vessels have probably experienced the disagreeable effects of this gas, to a greater or less extent. Its complete elimination from the living quarters of a yacht or vessel ought to be an important consideration.

On the score not only of general comfort and livableness but of safety, I am strongly in favor of the use of electric lights on any motor craft of sufficient size to carry a serviceably large plant. On the *Idaho* we had a very perfect installation, and the comfort of always having plenty of light without the smell and other disagreeable features of kerosene can hardly be expressed. On the first night of the race we were unfortunate enough to clog a gasoline pipe, by which we lost an hour and a half of precious time and, incidentally, the race. As we were beaten by only thirty-five minutes, that hour and a half always weighed heavily on all those interested in the boat. At the same time, if we had not had electric lights with which to work, we could have done nothing towards freeing the clogged pipe until daylight. During the time we were working on the pipe, the engineer deliberately let several gallons of gasoline flow out into the boat and over the engine room floor. This may not have been a very prudent proceeding in any case, but it would have been an almost sure invitation to disaster had we tried it with any other system of lighting. The dynamo which drives this plant is secured to the forward cylinder head of the engine, and is driven by a belt. This belt is protected by a rigid iron guard, and neither dynamo nor belt is in the way in the slightest degree. Under the cockpit we had five cases of four cells each of storage batteries. These would run all the lights on the boat, about fifteen in number, for four hours, but as more than three or four lights at a time are very seldom required, there is really ample capacity for two or three nights' use of light without recharging. The switchboard is very ingeniously arranged with a rheostat controlling the voltage of the generator, and a five-point switch which throws in, one after the other, the cells in the last case of batteries, so that when the voltage begins to drop a little it can be maintained for a considerable time with the endalls before it becomes necessary to recharge. Voltmeter, ammeter and the required switches are arranged as usual. Tell-tale red and green lights, which cannot burn unless the side lights are lighted, are a very good feature, indicating at once in the engine room if a side light goes out. On deck we had a 9-inch searchlight of about 1,500 candle power. This will throw a brilliant beam into the sky, which is useful for signaling purposes, and on a dark night will light up objects at a distance of a good half-mile with sufficient clearness. Considering that the plant occupied very little space, required very little power and almost no attention, I think it was well worth while.

Turning from these details of general design and arrangement, I wish to say a few words with regard to engine and fuel problems. It does not require a prophet to foresee that in the very near future owners of motor yachts will rebel at the cost of gasoline. Even now its expense is prohibitive for commercial use in high powers, and the building of gasoline yachts has undoubtedly been restricted by its cost. As alternatives we have kerosene (paraffin) or producer gas, made either from coal or heavy oils. There seems to be no difficulty in the operation of certain types of motors by kerosene, but in some instances of which I have known there have been decided drawbacks to its use. At the same time the reduction in expense, although amounting to nearly 50 percent as compared with gasoline, does not bring the operating cost as low as that of a good steam plant for a moderate sized vessel. Of the use of crude oils and distillates we have not had much experience in this part of the country, but on the Pacific Coast vessels of 150 feet and over, which are driven by engines using crude oils, are not uncommon.

On the whole, the use of producer gas from coal seems to promise the best results both for yachts and commercial vessels, although when expense is not an object gasoline will continue to be used. This will undoubtedly be the case with a great many small launches, all speed launches, submarines, and vessels such as torpedo craft, which may be driven by motors in the future. For yachts the up-draft producer with hard coal will probably be employed, but the type to be used is at present a matter which concerns the engineer rather than the architect. There seems to be no reason why gas producers, substantially like those in operation on land, cannot be used successfully on ships, and in combination with an efficient motor they offer very great advantages over steam plants. With a good producer a thermal efficiency of 87 percent can be reached, and I understand that it is perfectly safe to count on 75 percent under ordinary service conditions of operation. The fuel consumption can be figured safely as half that of steam.

In connection with comparisons of fuel consumption, and incidentally with weights and efficiencies as between gas and steam engines, I have noticed that quite often the average figures of the gas engine are compared with rather ideal figures of the steam engine, to the detriment of the former. In present practice the average of the gas producer engine is about 1 pound of coal per horsepower-hour, but under good conditions, with a 350-horsepower engine, a rate of as low as ¾ pound per horsepower-hour has been obtained. Therefore, I do not think it is unfair to say that it is safe to figure the fuel consumption of a producer gas engine as half that of steam under similar operating conditions. In the same way we may safely assume that the weight of the complete gas power plant and the space occupied is from one-half to two-thirds that of steam. Of course these figures are only approximations, but I think there is no question that in units up to 500 horsepower they can be "made good" to-day. When we think of the reductions in weight which have been brought about in the last thirty years in steam engines and boilers, it is only fair to suppose that when gas engineers have a chance to introduce corresponding refinements they, too, will be able to make a vastly better showing.

There are undoubtedly many mechanical difficulties to be overcome; likewise it is only reasonable to suppose that with every step in advance new and unforeseen obstacles will arise, but with such a goal ahead as the gas engineer will have, I have perfect faith that he will be found equal to his task. While I am especially anxious not to appear as a partisan of the explosive motor, and recognize what marvels of mechanism are embodied in some modern steam engines, I believe that we are on the eve of a great revolution in marine propulsion. There is at least so much promise in this field that it is well worth the while of every naval architect in this country to afford what opportunity he can for exhausting all the possibilities, and if by any chance it turns out that we have been working on the right lines, and secure a lead over the rest of the world, we shall have taken a long step toward regaining for the country that position of importance on the high seas which all of us desire. At the present time much of the best work in developing low-cost fuels for the use of explosive motors is being done abroad, and if we do not show improvement in this respect England and Germany will soon be far ahead of us.

It is reported that the Chilean merchant marine is increasing very rapidly, and at present is exceeded by that of only one South American country—Brazil—which has a tonnage of 211,194 against 156,316 for Chile. Of the Chilean shipping, 107,727 tons are steam and 48,589 sail.

A GERMAN MOTOR CRUISER.*

BY PROF. WALTER MENTZ.

Up to date in Germany comparatively few seaworthy motor boats have been constructed which can make long cruises far from a base of supplies; for this reason the *Ouestphalia* will be of some interest. She has a length of 16 meters (52 feet 6 inches); a beam over the planking of 2.85 meters (9 feet 4½ inches); a depth of hull of 1.5 meters (4 feet 11 inches); a maximum draft of 0.8 meter (31½ inches), and a displacement of 8.2 metric tons (8.07 gross tons).

The length and draft of the boat were firmly fixed by a winding channel through which it was necessary to operate her between a small lake near the owner's home and open waters. In a similar manner the height of the vessel was circumscribed by reason of several low bridges under which she had to pass. In particular the davits had to be fitted so that they could be removed, and the mast was hinged. The raised steering position was similarly affected. The requirements called for two cabins, which could also be used as sleeping quarters for two persons each, and space for two members of the crew to sleep.

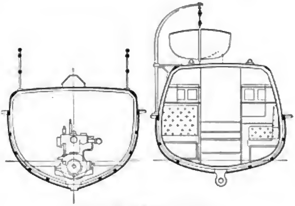
The construction of the vessel was by Fr. Luerssen, in Aumund-Vegesack, and the entire machinery equipment was superintended by the builder. The contract called for a speed, with a 23-horsepower motor, of 16 kilometers per hour (8 2/3 knots). In order to reach this speed, and also to enable the boat to be transported on the railroad, it was necessary to limit the beam to the figure above given.

The hull is of novel construction, using steel frames with continuous longitudinal members and double planking with diagonal seams. As all the frames are carried up to the upper deck, and are here bound together by wooden deck beams, great transverse strength and elasticity of the hull are provided, particularly against such forces as come from stress of weather.

The frames, 31½ inches apart, are angles 1⅜ by 1⅜ by 5/32 inches, with beams of the same size carried across under the flooring. The pitch pine longitudinals, 2 by 2 inches, are outside the frames, and the inner course of planking (½-inch oak) is laid diagonally. The outer course is also of oak, 19/32 inch thick. The deck beams are spaced 15¾ inches, and consist of oak beams 1⅜ by 1 3/16 inches, with an iron bar 1⅜ by 5/16 inches alongside. The engine frame is carried on two longtudinal channels 4¼ by 2⅛ by 9/32 inches. The keel, 7⅛ by 4 inches, and the sternpost, as well as the longitudinal along the upper corner of the cabin, are of oak. The stem, gunwales and deckhouse are of mahogany. The deck is of Oregon pine; the flooring of larch. In the engine room the flooring is covered with 3/16 inch of lead.

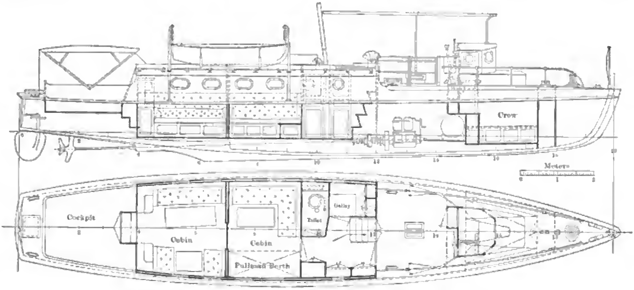
The accommodation plan shows forward a chain locker with a small capstan above it. Then comes a crew space with lockers; next is the engine room, which contains the cylindrical gasoline (petrol) tank running athwartships at the forward end, and the engine and reversing gear. The galley and toilet occupy the next compartment, aft of which are the two cabins, each fitted with folding tables. This comprises all of the portion of the vessel covered by a deck. The after end is an open cockpit, with a canopy over it. The control station is located just above the intersection between the crew space

THE GERMAN CRUISING MOTOR BOAT OUESTPHALIA.



FRAME 13.—SECTIONS.—FRAME 4.

* *Schiffbau.*



GENERAL ARRANGEMENT, PLAN AND INBOARD PROFILE OF THE MOTOR CRUISER OUESTPHALIA.

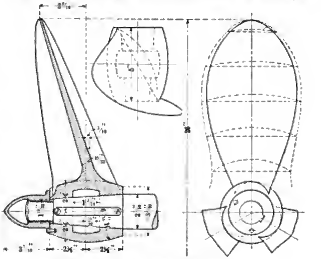
and the engine room, while a boat carried on davits from the starboard side is placed above the two cabins.

The engine is a two-cylinder Gardner motor with cylinders 7 inches in diameter and 6-inch stroke. The fuel contains an admixture of 20 percent of benzol. For reversing, the Hele-Shaw gear is fitted. The engine operates at about 600 revolutions per minute. Its weight, including the fly-wheel, is 710 kilograms (1,565 pounds). The reversing gear weighs 250 kilograms (551 pounds). The fuel tank holds enough fuel for a 26-hour run at full power. The air pressure tanks for signaling are placed in the engine room, the pressure being maintained by a small pump, which can be operated by a friction drive from the fly-wheel.

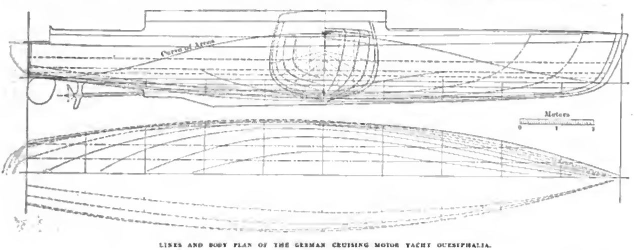
The deck over the accommodations is sheathed on the underside with wood ⅜ inch thick. The deck plank itself is 1 inch thick. The floors are covered with linoleum, and the trimmings are in mahogany. In the forward cabin the sofas are upholstered in moquette, while the after cabin is upholstered in neat's leather. All the sofas are arranged for occasional use for sleeping.

Ventilation of the crew space, the engine room, the galley and the toilet room is accomplished by ventilators fitted with small exhausters. The tender is made of cedar and fitted with sails. It has a length of 3.2 meters (10 feet 6 inches); and is easily handled by the davits.

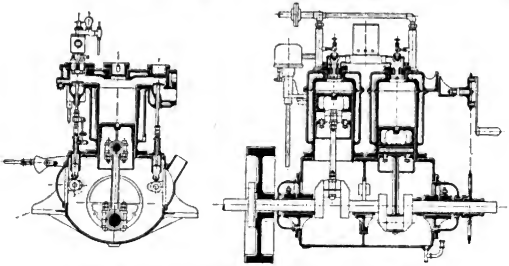
The propeller is solid, three-bladed, made of Niemeyer



PROPELLER DETAILS ON THE OUESTPHALIA.



LINES AND BODY PLAN OF THE GERMAN CRUISING MOTOR YACHT OUESTPHALIA.

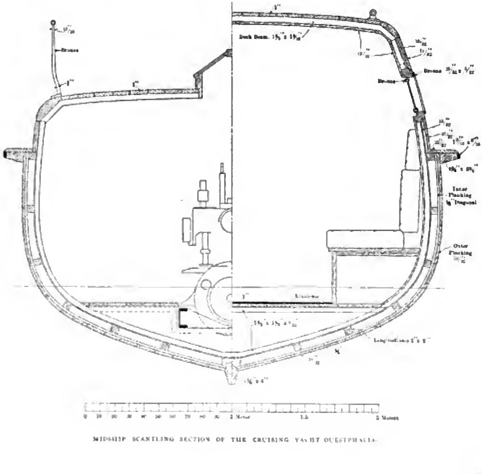


TRANSVERSE AND LONGITUDINAL SECTIONS OF TWO-CYLINDER ENGINE OF OUESTPHALIA.

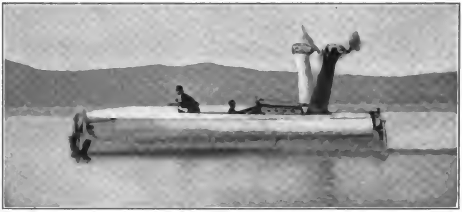
propeller bronze. It has a diameter of 660 millimeters (26 inches) and a pitch of 580 millimeters (22¾ inches); the pitch ratio is 0.88. The projected area of blades is 1,026 square centimeters (159 square inches); this gives 0.3 as the ratio between the projected area and the disk area.

On trial a speed of 16.1 kilometers per hour (8.68 knots) was obtained with 570 revolutions per minute, and a slip of about 19 percent. This trial was run in water with a depth of from 5 to 6 meters (16 to 20 feet), and against the current. The maneuvering qualities of the boat proved very good. In particular it was noticed that the wave thrown up was slight. The stability in a heavy seaway is said to leave little to be desired. The metacentric height is given as 73 centimeters (28.7 inches).

The Craig Shipbuilding Company is progressing rapidly in the construction of a complete shipbuilding plant at Long Beach, Cal., just south of Los Angeles. The buildings under construction include a structural iron shop, machine shop, mold loft, power house and foundry.



MIDSHIP SCANTLING SECTION OF THE CRUISING YACHT OUESTPHALIA.



THE CROCCO-RICALDONI HYDROPLANE AT FULL SPEED ON TRIAL TRIP: HULL 18 INCHES OUT OF WATER.

The Crocco-Ricaldoni Hydroplane Boat.

BY J. B. VAN BRUSSEL.

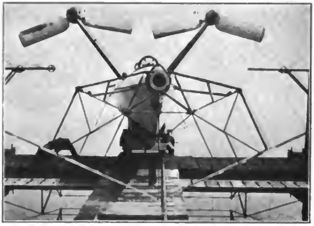
Two Italian officers, Lieutenant Crocco and Captain Ricaldoni, are experimenting with a new hydroplane motor boat of their designs, which presents some original features. The length is 8 meters (26 feet 3 inches), and she is fitted with a Clément-Bayard 80 to 100-horsepower motor, having cylinders 180 by 180 millimeters (7.09 by 7.09 inches), and working at a speed of 1,200 revolutions per minute.

It will be seen from the illustrations that the boat is provided with hydroplanes only at its stem and stern. The planes at the bow are arranged in the manner of a "V," while those aft, though similarly disposed, do not join at the inverted apex. These planes, and the principal members of the frames supporting them, are made of steel plating, the remaining parts of the carrier frame being of aluminum.

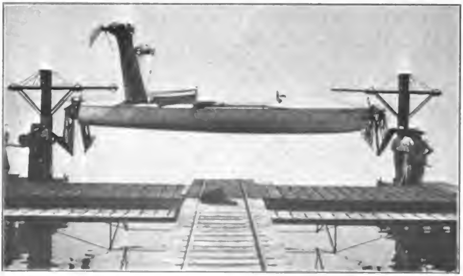
The aerial propellers, which operate only in the air, not in water, are of doubled aluminum plating, and weigh each about 12 kilos (26.4 pounds). Their pitch can be altered while running, and they can be reversed. They are mounted on frames of aluminum sheeting which, together with the shafts, gear, transmission, controlling devices, etc., weigh 300 kilos (660 pounds). The weight of the motor is also 660 pounds. Including all machinery, fuel, etc., and two men on board, the vessel weighs 1,500 kilos (3,300 pounds).

When running, the boat rises so that the hull is clear of the water, and at the high speed of 70 kilometers (43.5 statute miles) per hour, which has been obtained with this novel form of vessel, the hull is about 18 inches out of the water. One of the photographs shows the boat at full speed, supported solely by the "V"-shaped planes, the hull being clear of the water as described.

We are informed by the inventors of this boat that on



BOW VIEW, SHOWING THE BROAD, LOW, V-SHAPED PLANES.



BROADSIDE VIEW OF THE CROCCO-RICALDONI HYDROPLANE BOAT.

commencing a run, when a speed of about 10 kilometers (6.2 miles) per hour is attained, the bows begin to lift in the water, and the fore fins slowly emerge as the speed increases. At a speed of 25 kilometers (15.5 miles) per hour, the hull is wholly out of the water, only the flat portion near the stern skimming on the surface. At from 30 to 35 kilometers (18.6 to 21.7 miles) the boat is supported solely by the "V"-shaped planes; and at the highest speeds yet attained the hull is, as we have already stated, 18 inches out of the water. It has been found that waves of a height of 20 centimeters (8 inches) do not affect the vessel, as at the high speeds the hull stands quite clear of the tops of waves of this size. Trials over a course of 6 kilometers (3.73 miles) have been run, and sharp turns have been taken while running. After a certain amount of further experimental work, the inventors propose to put the boat through still more exhaustive trials, under as varied conditions as possible.

STERN VIEW, SHOWING THE TWO SEPARATE INCLINED PLANES.

Overhauling the Marine Engine.*

BY E. J. WILLIAMS.

At a time when very few motor craft have been put into commission, a great deal yet remains to be done when the pleasant weather arrives. Lots of things are left undone. For instanee, a great deal of care is expended in caring for the hull and fittings. The paint in most cases is burned and scraped off; calking removed from bad seams, and recalked and puttied; two coats of paint, at least, again put on; the varnish scraped off of the natural wood, and two coats of varnish again put on, after it is thoroughly sandpapered. Now, these details to the hull are all right, and the more attention you give to this work each season, the better boat you have after several years' use, and I might say even abuse. With all this hard, laborious task or precaution of making the hull of the boat presentable and seaworthy in every detail to the extent of the motorist's ingenuity and knowledge, yet the essentials or vitals are too often sadly neglected, through gross negligence. A pretty boat does not make a craft reliable and ideal in its full equipment; at least the writer has never found out the trick yet.

The vitals of a motor boat are its power equipment. The reliability of such a craft is dependent upon the proper performance of the power equipment. A little feature neglected here or there may cause untold worry at some critical time in the near future. Usually, though it might be well to say not always, because there are certainly a lot of good, sound, sensible thinking ones, all the attention given to the power equipment consists in installing a new set of batteries or recharging an old set, and wiping off the engine and polishing the brass parts; and this essential part of the power boat is ready for business again, according to the best of their knowledge. This has reference to the one-man control boat, in which all the work is done by the owner, who alone handles the boat, and on whom he has to depend for satisfactory results.

To the man who has the ingenuity or knowledge to completely overhaul and take apart the power equipment from beginning to end, the reward is naturally reaped in a good performance for the season, because parts requiring attention and replacing can be attended to, and endeavors made to have as good results as when the outfit was originally installed. Worn bearings can be determined, connecting rod, crankpin bearings, and crankshaft bearing tightened or made a perfect fit, piston rings loosened, or arranged properly, oiler and oil ducts cleaned, permitting a proper positive flow of lubricant, fuel tank and pipe washed out, carbureter cleansed, corrosion removed from all parts, ignition system installed anew, stuffing boxes repacked, all adjustments taken up, water circulation looked over and exhaust pipe overhauled.

Because many engines have no removable cylinder head, a great many have come to the conclusion that the engine should never be taken apart. No matter what the other fellow says, the liability of carbon or soot forming on the cylinder walls, near the piston's top center, is not eliminated with such an engine, and the only way of getting at it is to remove the whole cylinder up off the piston. The writer recently had a case of this kind wherein a second-hand engine had been installed in a new boat. The owner's inability to get the engine started caused him to seek some one's services to locate what he claimed was wrong adjustment of the carbureter. It was found that the flywheel could hardly be turned over by hand with the compression relief cock wide open, and it was a certainty that an explosion in a cylinder, with such a state of affairs existing, could not force the piston over the next half of the stroke. An explosion could be had each time the igniter snapped, but it was a plain case of piston binding at the top of the stroke. The only remedy was to slide the cylinder up and off, clean the carbon and soot from the top of the piston bearing surface, see that the rings were free, and put it back, when it worked perfectly.

When the power boat is laid up in the fall, the engine should at least be partly cared for, as the winter is liable to work wonderfully peculiar ravages in the way of rust. In the spring the old ignition equipment wires should be removed, especially if the boat is used on salt water, and new wires strung, unless the wiring is located in the cabin, and of a good size (say number 14 B. & S. gage) and properly insulated. The writer has seen an unprotected piece of wire of number 18 gage corrode to the thickness of a hair by being in contact with salt air, even under cover from spray. Another place where corrosion is liable to appear is at a point where an iron staple holds the wire in place. The insulation may have been broken so that the rust from the iron staple reaches the copper wire, and the salt air starts up a chemical action resulting in a heavy corrosion. The wire may eventually give way or produce such a resistance at this point as to require a great deal more current to effectually operate the coil, or give a satisfactory spark to ignite the mixture.

To offset any of these possibilities and take no chance on what is an uncertainty, the only safe method is to rewire the whole thing if the craft is an open boat. Lead-armored wire gives the best results, but is seldom used. If more ignition installations contained such a grade of wire, the possibility of such a trouble occurring in the wiring system for several years to come would be entirely done away with. Many installations contain only a grade of common electric bell or annunciation wire. If lead-covered wire is unobtainable, safety wire, consisting of, first, a soft rubber insulation surrounding the wire,

* *The Gas Engine.*

and over this a woven cloth soaked in wax or an insulated compound, can be purchased from any electrical contractor. The secondary wire in jump-spark ignition in open boats is invariably a source of annoyance from severe shocks when coming in contact with same. Hard-rubber tubes slipped over the secondary wire, the ends being made tight by binding with insulating tape, give good results. Flying spray is another incumbrance besetting the pleasures of motor boating, if it happens to touch the spark plugs. While very few persons appear to appreciate the usefulness of weather-proof spark plug protection, more will eventually yield to the notion that it is a more sane idea than a mere fad, which appears at present to be the general opinion.

All binding posts on the coil, engine, timer, switch, batteries, etc., should be brightened with fine sandpaper, so as to give a good contact. All contact points on the timer, coil and switch should also be brightened in the same manner. Adjustments on the timer should be made, and all springs made to operate freely, and new ones put in where required. The vibrating spring on the jump-spark coil ought to be taken off and all rust removed, so that it has a free action. Renew any worn springs on the make-and-break ignition mechanism, and brighten the spark points inside of the cylinder.

Galvanized iron fuel tanks should be thoroughly scrubbed out each spring. Annealed copper tanks for gasoline are to be preferred to galvanized iron, owing to a white sediment from the latter finding its way to the carbureter. One length of annealed copper or hard lead for fuel supply pipe, with soldered connections, is also highly recommended. The circulating water pump should be taken apart and all corrosion removed. Take apart all check valves and remove the rust invariably found therein, so that the check has a good seat. If the cylinder head is removable, take it off and remove whatever scale and rust from the cylinder water jacket that it is possible to get off. A clean jacket does its work effectively.

Look over the muffler and exhaust pipe line and remove any broken or thin pipe or fitting. While appearing perfectly solid to the eye, a light tap with a hammer often goes through a shell in the exhaust pipe line, the thinness of which will surprise you, especially if your overflow circulating water empties into the exhaust line. If any portion of the exhaust pipe contains an asbestos covering, look it over, and if burned to any extent whatever, remove the section and put in a new piece. Take no chances that it will last the season out, or you may find your boat on fire, with damaging results.

If the engine is a four-cycle outfit, look over the valves and valve seats, springs, lifts, etc. Grind in whichever ones require it, preferably all, so that a perfect seat is assured. Pour kerosene (paraffin) oil on the valve stem guides and springs, and thoroughly clean all parts pertaining thereto, so that a free valve movement is obtained. If any valves require renewing in any way, don't neglect it. Before the boat goes overboard be sure and see that the strainer of the outboard water circulation is clear of any foreign substance. Sliding the boat over the sand, mud, or dirt may clog up the inlet pipe. Small details should be attended to before the boat goes overboard, or it is "nine chances out of ten" they will be forgotten. I might go on for some time telling things that were right and wrong, but the foregoing should jog the memory of those interested, so that they will see the importance of having the power equipment right. One more reminder;—get a new piece of chamois to strain the gasoline (petrol), or wash out the old one with soap and water and let dry, and when the boat is ready to go into the water stow away a bucket of sand to be used as a fire extinguisher,—you may be able to help someone else in case of a fire.

Eads Johnson, formerly of James Shewan & Sons, New York, has taken charge of the New York office (12 Broadway) of the New York Shipbuilding Company, Camden, N. J.

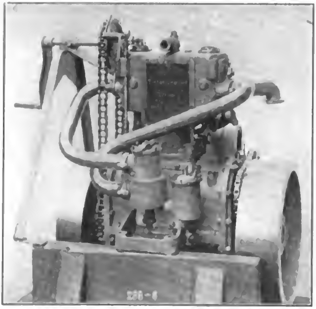
A Small Motor Tender.

John I. Thornycroft & Company, Ltd., Chiswick, built last year for Mr. Longbottom's steam yacht *Rubicon* a particularly smart looking tender, carvel built of mahogany, close jointed and varnished inside and out. The decks forward and aft are also of mahogany. The floors are covered with American elm gratings. The length is 19 feet 6 inches, beam 5 feet, and the maximum depth 3 feet 8 inches.

The power is transmitted by a Thornycroft 6 brake horsepower motor, through a reversing gear to a Thornycroft solid propeller of large diameter, specially designed for towing. It was anticipated that a towing speed of about 4 miles per hour could be easily maintained, and in view of the fact that the *Rubicon* is of 90 tons yacht measurement, this is a very satisfactory performance.

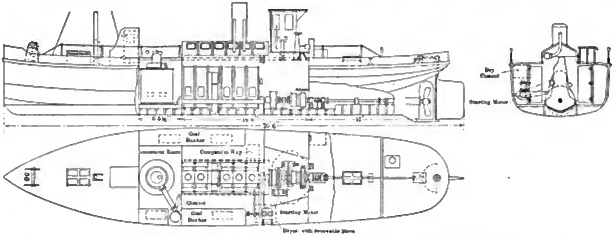
MOTOR TENDER FOR THE STEAM YACHT RUBICON.

The fuel tank is of brass, and all petrol (gasoline) and water pipes are of solid drawn copper. The motor is completely covered and protected from rain and spray by a neat mahogany casing. The boat is provided with two hoods, one over the engine space and the other over the cockpit, each fitted with talc lights.



SIX-HORSEPOWER MOTOR IN TENDER TO STEAM YACHT RUBICON.

Slings are provided for hanging in davits, and it is owing to the space and weight being limited for this purpose that special provision has had to be made to keep weight down to a minimum, while still leaving a good margin for strength. The contract stipulated 13 cwts., but the builders found they had ample margin, the actual weight being about 12 cwts., while the staunchness and seaworthy qualities were very apparent, and in no way impaired by the light construction. A



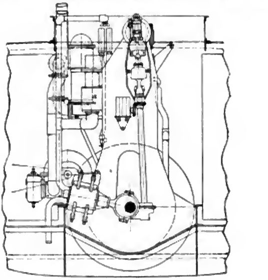
THE TUG WILHELM, PROPELLED BY A SUCTION PRODUCER PLANT ON THE CAPITAINE SYSTEM.

boat of this type would be equally useful for up-river work, or cruising in more or less sheltered waters, and its moderate initial cost, economy in fuel and maintenance should recommend the type strongly to those in search of a small, well-built and handy motor boat.

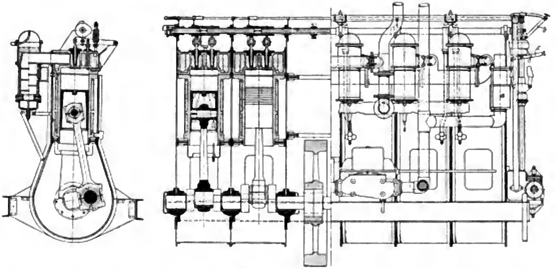
The Producer Gas Towboat Wilhelm.

This is a boat built by the engine and shipbuilding plant of Fritz Luennemann, in Ruhrort, and provided with a suction gas motor of from 160 to 175 horsepower, working on the Emil Capitaine system.

The vessel has a length of 20 meters (65 feet 7 inches) and breadth of 4.5 meters (14 feet 9 inches). Three watertight bulkheads divide the hull into four compartments. The forward compartment is occupied by the captain and helmsman; the second and third compartments by the machinery, including the producer, the five-cylinder engine and the reversing gear; while the after compartment is devoted to the crew, and below it runs the propeller shaft. The engine room, which is the third compartment from the bow, has a length of 5.95 meters (19 feet 6 inches). Besides the reversing gear for the propeller, this contains also the steering apparatus, carried up above the deck in a small pilot house. Aside from the skylight and companion forward, engine hatch and pilot house amidships, and a small skylight for the crew space, the



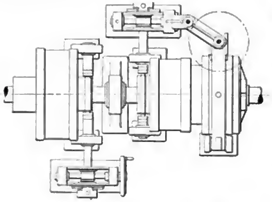
AFTER END VIEW OF ENGINE, SHOWING CARBURETER AT G.

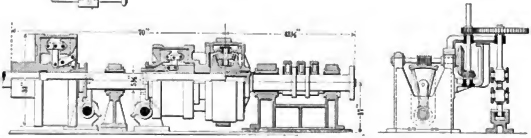


TRANSVERSE AND PARTIAL LONGITUDINAL SECTION OF THE FIVE-CYLINDER ENGINE, WITH PARTIAL LONGITUDINAL ELEVATION.

deck is quite clear of obstruction. Fuel is carried in two wing bunkers alongside the producer and engine.

The engine cylinders are mounted on a frame of iron plates, which is stiffened and strengthened with angle irons. Each of the five cylinders has a diameter of 300 millimeters (11¾ inches) and a stroke of 400 millimeters (15¾ inches). The fly-wheel is between the first two cylinders and the last three. The exhaust pipes are placed on the sides of the cylinders, and are fitted with mufflers, consisting of cylinders filled with baffle plates and jacketed with water. This water is thus evaporated for the use of the generator in its function of providing the gas. Ignition is governed by adjustable cam wheels located upon the tops of the cylinders. A small starting engine is provided in the shape of a two-cylinder benzine motor, which is connected with the main engine by a leather belt. This motor also drives a centrifugal pump, which controls the gas coming from the generator through the cleaner before passing it into the cylinder. The working volume in the cylinders has practically no clearance space. All the exhaust channels and valves are well cooled on all sides, so that radiation from the engine is very slight.





REVERSING CLUTCH FOR THE PROPELLER-SHAFT COUPLING ON THE PRODUCER-GAS VESSEL WILHELM.

Each exhaust valve consists of a cast body with a malleable iron jacket; between the jacket and the body is cooling water, which, again, is vaporized for the use of the producer. It is said that a very short time is necessary between the starting of the producer and the production of the gas, giving full power to the engine. When the motor runs light there is a coupling between the motor and the shaft which can be released by means of a hand-wheel on the deck. A second coupling aft of this one serves as a reverse gear for the propeller.

For firing the generator, usually the best anthracite nut coal is used, costing about 22 to 23 marks ($5.25 to $5.50; 21/6 to 22/6) per ton. In a trip last spring with a load of 300 tons, 60 kilograms (132 pounds) of coal was burned per hour. The generator was cared for only once during each hour. The operation of the engine proved itself very regular under heavy load. The speed of the ship, empty, against the stream is about 22 kilometers per hour (12 knots).—*Zeitschrift des Vereines deutscher Ingenieure.*

The Stormy Petrel.

This is one of half a dozen vessels built last summer by Summers & Payne, Ltd., Southampton, for members of the Motor Yacht Club. They are very complete little cruisers, carvel built, with a short deck fore and aft and with two hoods, enabling them to keep passengers dry at all times.

THE 25-FOOT LAUNCH STORMY PETREL.

Each one has a length of 25 feet, a breadth of 5 feet 9 inches and a depth of 2 feet 9 inches.

The Wolseley engines have two cylinders, giving 10 or 12 horsepower, with a consistent speed of 9 miles per hour. These motors are of the two-cycle type, without valves, and, having very few working parts, are extremely simple in handling.

A Forty-Foot Cruising Cabin Launch.

One of the most striking exhibits at the New York Motor Boat Show was a high freeboard cruising launch built by the Racine Boat Manufacturing Company, Muskegon, Mich. The freeboard is such as would make this boat especially valuable for use in off-shore cruising, and against a heavy sea, as will be amply attested by the drawing. The length of the hull over all is 40 feet, with a beam of 8 feet 9 inches and a draft of 3 feet.

The stem and stern posts, keel and transom are of white oak, thoroughly riveted together, and with galvanized iron fastenings. The frames are of specially selected straight green white oak, bent to shape in a steam bath and fastened to the white oak floor timbers, which are riveted through the keel. The entire hull is planked with 1-inch Michigan white cedar, except for the garboard and sheer strakes, which are of oak. The skin fastenings are brass screws. Planking butts are reinforced with oak doublings, while the clamps are of yellow pine. The engine foundation is a heavy structure of white oak, being specially designed for the limitation of vibration. The decking for the cabin is of white cedar laid fore and aft and covered with 10-ounce duck, cemented on. An oak foot rail is fitted on either side, with an after deck and waterways of oak.

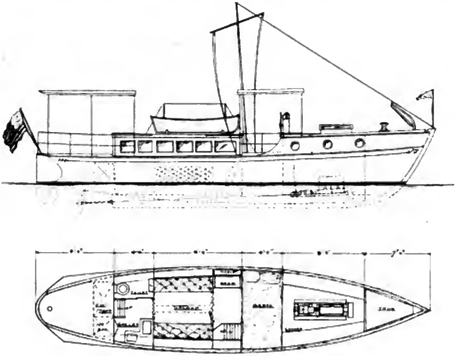
The forecastle is formed by an upward extension of the hull framing and planking, with a roof of beaded and matched cedar, covered with heavy duck and made waterproof with lead paint. The edges of the deck are covered with oak molding. The deck beams are of oak, with a slight crown. In the forecastle are located the gasoline tank (forward of the collision bulkhead), the chain locker and the engine room. A pipe berth on each side above the engine furnishes accommodation for two engineers. Directly above the engine is a skylight, with bronze fittings and protecting rods. This room has six hinged bronze port lights, thus affording ample light.

The stateroom just aft of the engine room has two smaller port lights, one on either side, and opens from the saloon, in which are two sofa berths and a folding table. The exterior finish of the saloon, which projects above the after deck of the boat, is in mahogany. The interior is white enamel with mahogany trim. Six square windows are fitted on either side, being hinged at the bottom. The roof beams are of mahogany, with white cedar panels finished in white enamel between them. Plate-glass mirrors are fitted on the bulkheads leading from the saloon to the stateroom and to the galley and toilet respectively. Lockers are fitted under the sofas, the latter being upholstered, back and seat, in green plush. Green tapestry curtains are fitted at each of the two exits from the saloon.

Aft of the saloon is a compartment containing the toilet on the port side and galley on the starboard. The latter is equipped with a two-burner oil stove, pump, dish rack, sink and locker, while an icebox under the after deck serves for the storage of provisions. To the port of the icebox is the fresh-water tank, also under the after deck.

The engine, which is of 20 horsepower, is of the 4-cycle type with four cylinders, an inboard reverse, and turns a solid three-bladed propeller. The engine is water jacketed throughout, is fitted with a float-feed carbureter, jump-spark ignition, and a rotary pump and bilge discharge. The reversing lever and throttle control are fitted at the steering wheel, so that one man can handle the entire equipment.

Electric lighting is provided by an Apple dynamo, driven by a friction gear from the fly-wheel of the engine. To supplement the dynamo there are two storage batteries, each with a capacity of 60 ampere-hours at six volts. The lighting is provided by twelve 6-volt lamps of 4 candlepower each. The equipment includes also polished brass Fresnel sailing lights, brass binnacle, a mast with a stationary yard for signaling purposes, two anchors with a davit for their operation, and a 9-foot canvas-covered tender carried on top of the cabin trunk, and handled by galvanized iron davits on the port side.



FORTY-FOOT CRUISING CABIN LAUNCH, BUILT BY THE RACINE BOAT MANUFACTURING COMPANY.

The Power Lifeboat Banfield Creek.

The Electric Launch Company, of Bayonne, N. J., has completed a power lifeboat for the Canadian Life Saving Service, which is said to show qualities far in advance of any boat previously constructed for this purpose. The plans and specifications were prepared by Capt. C. H. McLellan, R. C. S. (retired), formerly inspector of the United States Life Saving Service, and call for a boat 36 feet over all, 8 feet 1½ inches beam, built almost entirely of mahogany and fastened with gunmetal and copper, no iron being permitted.

It is diagonally planked in two layers, with canvas between, and is self-bailing and self-righting, with the crew lashed to the thwarts. The boat is divided into eight watertight compartments below the deck, and each compartment is filled with copper air cases, eighty-two in all. It is lug rigged with foresail, mainsail and jib, with hollow masts and gunmetal centerboard, and is also fitted for ten oars.

A 35-40-horsepower Holmes auto-marine, six-cylinder, four-cycle, gasoline (petrol) motor is installed in the after end compartment, which gives a speed of 9¾ miles per hour with 650 revolutions. The controls are so arranged on the outside of the compartment bulkhead, in recessed boxes, that the motor can be readily managed from the outside when the compartment is closed watertight.

A fuel tank of 125 gallons capacity is located in the lower hold just forward of the centerboard trunk, and an auxiliary fuel tank of 25 gallons capacity is placed under the turtle back of the forward end compartment, into which the fuel is

pumped from the main tank as required. The fuel pipe to the motor leads from the auxiliary tank outside along the garboard. A glass in the forward bulkhead enables the height of the fuel to be seen in the sight tube attached to the auxiliary tank.

The engine is fitted with jump spark ignition, the current being supplied by the Apple ignition apparatus, which also furnishes current for a stationary and drop light in the motor room and a light by the sight tube of the auxiliary tank forward. The whistle is operated by air, compressed by the motor. The boat is steered from a wheel, which can be instantly detached from the rudder head, in case the steering oars are to be used in a bad surf, and the rudder is to be triced up.

The boat has been sent to Victoria, B. C., and from there taken to Banfield Creek, Vancouver Island, which will be its station. This is one of the most dangerous locations for shipping on the Pacific Coast, being nearly opposite Cape Flattery, and is near the scene of the disastrous *Valencia* wreck, which occurred a few years ago. It is also near the point where international co-operation in lifesaving is soon to be a reality, with an American revenue cutter on duty in Neah Bay, and wireless stations along the coasts of Vancouver Island and the State of Washington.

A 16-HORSEPOWER FRENCH MOTOR BOAT.

THIRTY-SIX FOOT LIFEBOAT, BUILT FOR CANADIAN GOVERNMENT, AT BAYONNE, N. J.

A French Cruiser Motor Boat.

The cruiser *Delahaye IV* won the second prize for cruisers of 6.5 meters (21.3 feet) at the Chamtionnat de la Mer, and also at the D'Evian regatta for cruisers of 8 to 12 meters (26.2 to 39.4 feet). It has also won first prize for the same class of cruisers at the Nantes regatta, also at Coupe de Troudille and the Regates de Lucerne. At the Regatta du Havre this boat won second prize over a course of 100 miles, and first prize for cruisers 8 to 12 meters at the Regates du Lac-Majeur. This remarkable little French cruiser has an engine of only 16 horsepower, of the vertical four-cylinder type, having a normal speed of 1,250 revolutions per minute. The engine occupies a floor space of 1,250 by 500 millimeters (49¼ by 19¾ inches).

A Twenty-five Foot Semi-Cabin Cruiser.

The photograph shows the 25-foot cruiser *Hawk*, built by MacLaren Brothers, Sandpoint Yard, Dumbarton. The general arrangement of this launch shows a small store room in the forepeak; a cabin, including two sofa berths and folding table; an open cockpit, in which are located the engine (under a portable cover); a folding table and the steering position, and the after peak, in which is the fuel tank. On the forward deck, just ahead of the cabin turtle back, is a watertight hatch, giving access to the cabin and the stores. The length is 25 feet, beam 6 feet, depth 3 feet 3 inches and maximum draft 1 foot 8 inches.

The engine is a 6-horsepower Scout motor, with two cylinders, and operates the propeller shaft by means of a universal

THE MOTOR CRUISER HAWK, 25 FEET LONG.

joint, the engine crank shaft being horizontal. Reversing is accomplished by means of a lever and slide clutch operated from the steering position. This enables the entire management of the vessel to be placed under the control of one man. There is a bilge pump worked by the motor and put in action by means of a lever. The floor of the cockpit is covered with linoleum, while the motor, which projects beneath this floor, is fitted with a metallic tray.

The World's Shipbuilding in 1907.

Figures from various sources have been compiled showing the shipbuilding of the world during the year lately concluded. The various methods of compiling the figures have resulted in considerable variations in the totals given. The apparently most reliable figures which we have been able to find show an aggregate of 2,966,156 gross tons of merchant vessels, of which 1,654,533 tons, or 55.8 percent, were launched in the United Kingdom and the colonies. The total for the British Isles appears to be 1,620,853 tons, of which 139,442 tons represent the Irish construction (mainly Belfast); 840,995 tons were constructed in England, and 640,416 tons in Scotland; the construction in the colonies was 33,680 tons. In each case warship figures are omitted. Construction in other countries includes:

	1906.	1907.	Lloyd's.
United States.....	393,291	502,508	474,675
Germany	356,128	311,784	275,003
Holland	115,152	152,371	88,623
France	59,837	83,105	61,635
Japan	95,088	66,015	66,254
Italy	41,646	53,033	44,666
Norway	56,023	51,523	57,556
Other countries....	106,821	91,284	55,343

First on the list of separate yards for the year is William Doxford & Sons, Sunderland, with 91,254 tons and 40,063 horsepower, as compared with 90,907 tons and second rank in 1906. If, however, we include the several plants of the American Shipbuilding Company on the Great Lakes, we find that this company has constructed a much larger tonnage than any other in the world, the figures being 205,233 tons and 66,300 horsepower in 1907, and 195,930 tons in 1906. This includes seven yards, of which six were in operation in 1906. The largest of these yards accounts for 54,788 tons, which figure is exceeded by six British yards, including Doxford & Sons, Swan, Hunter & Wigham Richardson (80,573 tons), the Elswick yard (74,228 tons), Harland & Wolff (72,412 tons), Russell & Company (71,705 tons), and Workman, Clark & Company (63,245 tons); and also by the Great Lakes Engineering Works, Detroit (55,485 tons). The largest construction in Germany was by the Vulcan Works, Bremen, with 49,431 tons. No other yard in the world, outside of Great Britain, reached as much as 40,000 tons.

Of the total construction during the year only six vessels exceeded 10,000 tons, and none of these reached 13,000, while last year we had the two mammoth Cunarders of over 30,000 tons each, as well as the *Adriatic*, of almost 25,000 tons. Three of these largest ships are from the yard of Harland & Wolff, Belfast, while two others are from the Fairfield Company, Govan. The sixth—third in order of size—was built by Barclay, Curle & Company, Whiteinch.

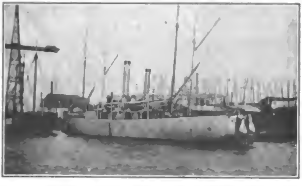
Figures given by Lloyd's Register differ somewhat from those collected from other sources. The annual summary of this Register states that 752 steamers of 1,581,521 gross tons, and 89 sailing vessels of 26,369 gross tons, were launched during 1907 in the United Kingdom. This makes a total of 841 vessels and 1,607,890 tons. This Register gives figures for merchant shipbuilding in other countries, as shown in our table, under their name. In each case it will be found that there is a marked difference from the figures collected from other sources, the total given for the world being 2,778,088 tons.

It might be of interest to compare some of the figures given in Lloyd's table of shipbuilding during the past sixteen years. In 1892 the total construction is given as 1,358,045 tons, of which the construction in Great Britain amounted to almost 82 percent; that in the United States was only 4.6 percent, while German construction was about 4.8 percent of the total. In 1897, the total construction is given as 1,331,924 tons, this having been a particularly lean year. Of this total, British ships accounted for 71.5 percent, American for 6.5 percent, and German for 10.5 percent. In 1902, out of a total construction of 2,502,755 tons, the British figures accounted for 57 percent, American for 15.1 percent, and German for 8.5 percent. In 1907, out of a total of 2,778,088 tons, British construction accounts for 58 percent, American for 17.1 percent, and German for 10 percent.

Warship construction is given by Lloyd's as 142 vessels of 321,211 tons displacement. Adding this to the merchant figures, the total construction for the world appears to have been 1,930 vessels, of an aggregate of 3,099,299 tons. Of men-o'-war, thirty-six ships of 134,475 tons were built in the United Kingdom, all except three, of 1,070 tons, being for the British Navy. Construction in other countries include sixteen in Japan, of 61,100 tons, of which six of 3,000 tons were for China; twenty-four in France, of 35,289 tons, of which seven of 1,695 tons were for Turkey; fifteen in Russia, of 34,617 tons; twelve in Italy, of 25,154 tons; twenty-one in Germany, of 16,200 tons, of which two of 700 tons were for Greece, and two of 700 tons for Russia; five in the United States, of 11,590 tons, and thirteen in other countries, aggregating 2,786 tons.

New Coast Guard Boats for Turkey.

A scout and five gunboats for the Turkish government have recently been completed at the Chantiers de la Loire. These



TWO SMALL TURKISH GUNBOATS, BUILT IN FRANCE.

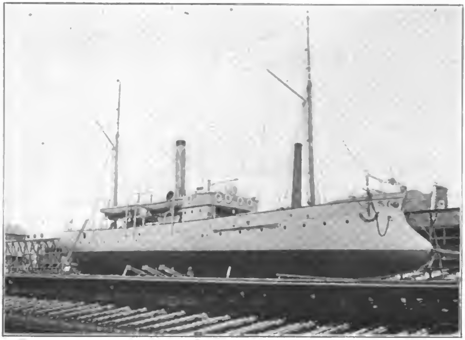
THE TURKISH COAST GUARD CRUISER MARMARIS ON SLIPWAY.

steamers are designed for coast guard work, and for the suppression of piracy and smuggling, and the settlement of varinous disputes along the Turkish coast in the Red Sea and the Persian Gulf. The scout has been named *Marmaris,* while the first of the gunboats has been called *Seddlibaschir.* These two types of vessels are quite different from each other, and are not at all in line with present up-to-date practice of the larger naval powers. For their own purpose, however, they will doubtless prove satisfactory.

The *Marmaris* has an armament including four 9-pounder and two 1-pounder guns and one 18-inch torpedo tube. She has a crew of twelve officers and fifty-four men. The gunboats are arranged for three 3-pounder and two 1-pounder guns with one torpedo tube, and are manned by nine officers and thirty-eight men.

The general dimensions of the two types are as follows:

	Marmaris.	*Gunboat.*
Total length	172 ft.	154 ft.
Extreme beam	24 ft. 7 ins.	18 ft. 10 ins.
Depth	13 ft. 9 ins.	11 ft.
Draft	11 ft. 10 ins.	7 ft. 11 ins.
Displacement in tons	422	309
Indicated horsepower	950	480
Speed in knots	14.81	12.45
Radius of action	2,000 miles	1,200 miles
Steam pressure	199 pounds	199 pounds
Scotch boilers	2	1
Sail area, in square feet	5,160	2,205



THE TURKISH COAST-GUARD GUNBOAT SEDDILBASCHIR ON SLIPWAY.

INTERNATIONAL MARINE ENGINEERING

Published Monthly at

17 Battery Place New York

By MARINE ENGINEERING, INCORPORATED

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President

E. L. SUMNER, Secretary

and at

Christopher St., Finsbury Square, London, E. C.

E. J. P. BENN, Director and Publisher

SIDNEY GRAVES KOON, Editor

Branch Offices { Philadelphia, Machinery Dept., The Bourse, S. W. ANNESS. Boston, 170 Summer St., S. I. CARPENTER.

Entered at New York Post Office as second-class matter.

The edition of this issue comprises 6,000 copies. We have no free list and accept no return copies.

Direct Steamship Service Between the Two Americas.

For many years there has been a large item of complaint on the part of merchants in the United States regarding the steamship service between that country and the countries on the east coast of South America. Strange as it may seem, it has usually been speedier and not more expensive to send mail, travelers and merchandise from the United States to England, and thence to Brazil and the Argentine Republic. The two latter-named countries are just about equally distant from the United States and England, and the strangeness of the whole proceeding lay in the necessity for sending whatever had to be sent across three thousand miles of the stormy North Atlantic, and then starting them on a journey of approximately the same extent as would have been the case had the shipment been made direct.

One of the main arguments brought up in the Congress of the United States in favor of a subsidy bill, be it mail subsidy or shipping subsidy, has been based upon the facts mentioned above. It is, naturally, very disconcerting to the pride of the average American merchant to be placed, as it were, in such subserviency to his British contemporary; and the element of time, always of much importance in matters of this kind, has made the argument a very strong one. The same subject is up again in the present Congress, and bids fair to win a limited modicum of success, in so far as the carrying of the mails is concerned. Whether or not this will result in any considerable accretion to the number and size of steamships plying between New York and Rio de Janeiro and Buenos Ayres remains to be seen, but the presumption is all in its favor.

Our first article this month covers a description of the first of a line of steamers, under the British flag, in which this identical service is to be carried on. Other steamers under construction will make up a fleet with which it is proposed to make two sailings per month in each direction, and thus maintain regular, systematic and comparatively rapid communication between the two halves of the American continent. This service is expected to be very good, so far as it goes; but the developments of the next few years will unquestionably show the need for a great augmentation in the number of ships sailing, and the frequency of opportunity to make the trip. In other words, it is highly probable that the demand will require sailings at least once a week, and possibly as often as twice a week. It is for this reason that the bill at present before Congress is being pushed, with the idea of placing at least a fair proportion of these vessels under the flag of the great nation most largely concerned in the trade. Such a consummation could be effected only by the construction in American yards of ships designed and destined for this particular service, and of sufficient number to bring the service up to the point where supply meets demand. This would serve as a very effective stimulus to shipbuilding on the Eastern coast of the United States, and, as such, would be heartily welcomed by all interests concerned.

Motor Boats.

The present number, as has been the case once or twice before with March numbers, is very largely given up to the subject of small boats propelled in the main by internal combustion engines. This is an industry which has grown from very small beginnings to a present enormous business; and while in general it is more or less removed from shipbuilding, so far as the large units are concerned, yet the general problems involved are pretty much the same, and much may be learned from experiments on these small vessels which will be of aid to the designer of large ones. Not the least of these features is in connection with the use of internal combustion engines operating upon suction

producer gas generated alongside the engine. One of the articles this month is a brief description of such a small vessel; and many have been the attempts to inaugurate such a system of producer gas plants and engines as would prove available for the propulsion of large vessels. This is not a new proposition, but up to date success has not been very marked, and no vessel of any considerable size has been fitted with the apparatus. Much has been done, however, in the way of experimentation, particularly upon these small plants, and all of this is simply a case of pioneering which will bear fruit in the near future in the application of this form of power to larger vessels.

Motor boats may be in general divided into three principal classes—those intended for business purposes, those intended for cruising and those intended for racing. The general principles underlying all of these classes are necessarily the same, but the details are worked out along totally different lines. The cruising vessels have broad and comparatively heavy hulls, where the racing vessels are narrower and with weights reduced to a minimum. The cruisers have engines of moderate power only, often of considerable weight in the interests of economy of operation, steadiness and reliability; where the racer is provided with engines of great power, and here again weights have been reduced to a very low figure. The racer is almost invariably an open boat, or one covered with a flush deck; the cruiser is frequently of this same type, but is perhaps more frequently fitted with some sort of a cabin, either under a turtle back forward, or reaching up amidships in the form of a deckhouse, the larger portion of which is below the main deck.

The business boat has many of the characteristics of each of the others, and, under certain conditions, very much resembles either the one or the other, depending upon the particular service to which it is to be applied. In many cases, however, we find a totally different sort of a proposition,—such, for instance, as in boats designed for oyster fishing, or for deep-sea fishing generally. In these cases we have a broad, flat boat of very little shapeliness, propelled by a small engine intended to develop a speed usually of not more than six to eight miles per hour. This engine is located in the extreme stern, and very little attention is given to whether or not the screw shaft has a considerable rake. The propeller is not operated at anything like its best efficiency, but gives such service as is demanded much more cheaply than it could be obtained with any other known form of propulsion except the wind. Most of these boats are fitted also with some provision of sails, which are used whenever the wind is available, and from this point of view the engine is largely an auxiliary. In any event, however, the boat is distinctly a motor boat, and is one whose usefulness is beyond question.

In addition to the regular forms of motor boats, there are other vessels propelled by internal combustion engines whenever occasion demands it. These are auxiliaries, intended usually for propulsion by sails, and fitted with the motor simply as a means of proceeding in a calm or against head winds. A conspicuous example of this type is the large schooner *Northland*, described at page 362 of our September, 1907, number. This is said to be the largest auxiliary schooner in existence, and is provided with a six-cylinder engine of not less than 500 horsepower. This vessel is of over 2,000 tons gross, and carries 9,000 square yards of canvas, upon which, in general, reliance is placed for propulsion. When necessary, however, the engine is found to give excellent satisfaction, the speed being from 5 to 6 knots, even under adverse circumstances. In this particular case, there are also smaller engines of the same general type, which are used for generating electricity. The electrical power is used for operating elevators, thus facilitating the handling of the cargo; for lighting the schooner electrically; and for operating a searchlight. These are all decided innovations in coastwise schooners, and illustrate rather forcibly the great utility of the small engine for auxiliary purposes upon vessels of this type.

A kindred use of internal combustion engines is in their fitting to large sailing yachts, be they sloops or schooners. Several such vessels have had these engines installed, either at the time of building or at a subsequent date, and much satisfaction has been derived from their use, whenever occasion has demanded the propulsion of the vessel by means other than her own sails. In other cases, where it was not found feasible to fit the auxiliaries, a small boat has been carried, in which an internal combustion engine was fitted for its propulsion. This boat has been used as a tender, carrying passengers to and from the shore, and has on occasion been impressed into service as a towboat. In this latter case the boat works at a very poor efficiency, but nevertheless, in general, it has been found to give a speed of three or four miles per hour, which has usually proved satisfactory. An example of this is illustrated this month on page 129.

In referring above to the *Northland*, we mentioned the two auxiliary engines generating electricity for various power and lighting purposes. This is a feature which is gaining more and more prominence, and which we may expect to see a very considerable item in vessels of the future, in which steam is not already provided by an equipment of boilers and steam machinery. The engine is particularly well adapted for this purpose, as it can be started almost at a moment's notice, and there is no fuel consumption whatever while the engine is not running. It differs markedly in this respect from the steam outfit, in which some time is required for getting up steam, and fuel is being burned, except in certain special cases, throughout a large portion of the time.

Progress of Naval Vessels.

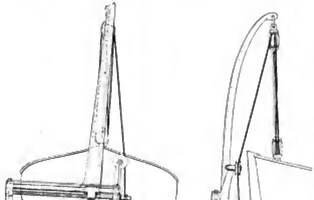
The Bureau of Construction and Repair, Navy Department, reports, Jan. 10, 1908, the following percentage of completion of vessels for the United States Navy:

	Tons.	Knots.		Dec. 1.	Jan. 1.
BATTLESHIPS.					
Mississippi	13,000	17	Wm. Cramp & Sons	98.01	98.65
Idaho	13,000	17	Wm Cramp & Sons	91.24	94.12
New Hampshire	16,000	18	New York Shipbuilding Co	93.1	95.3
South Carolina	16,000	18½	Wm. Cramp & Sons	31.68	33.76
Michigan	16,000	18½	New York Shipbuilding Co	33.5	37.9
Delaware	20,000	21	Newport News S. B. & D. D. Co	5.08	7.05
North Dakota	20,000	21	Fore River Shipbuilding Co.	7.84	12.7
ARMORED CRUISERS.					
North Carolina	14,500	22	Newport News Co.	95.17	96
Montana	14,500	22	Newport News Co	89.49	91.31
SCOUT CRUISERS.					
Chester	3,750	24	Bath Iron Works	94	95.15
Birmingham	3,750	24	Fore River Shipbuilding Co.	91.88	93.71
Salem	3,750	24	Fore River Shipbuilding Co.	90.29	92.09
TORPEDO BOAT DESTROYERS.					
Number 17	700	28	Wm. Cramp & Sons	.....	0.0
Number 18	700	28	Wm. Cramp & Sons	.....	0.0
Number 19	700	28	New York Shipbuilding Co.	.....	3.4
Number 20	700	28	Bath Iron Works	.....	0.0
Number 21	700	28	Bath Iron Works	.....	0.0
SUBMARINE TORPEDO BOATS.					
Cuttlefish	—	—	Fore River Shipbuilding Co.	99	99

ENGINEERING SPECIALTIES.

Boat Lowering Gear.

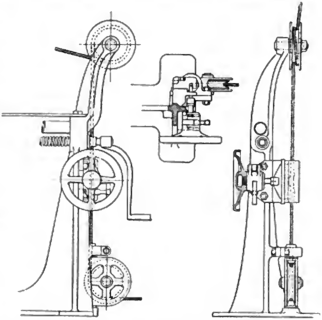
In combination with the Welin quadrant davit, it is desirable to have some means providing for the lowering and hoisting as well as the swinging out. Mr. Welin has already gotten out one or two designs for this purpose, and anyone insisting upon a winch arrangement attached to each davit or each pair of davits can have it. It should not be difficult to lower the boat



as long as the belaying pins are properly made; and the plan has been to keep the whole mechanism as simple as possible.

One of the illustrations shows a drum and brake attached to the Welin davit, and the other shows a simple clutch for lowering. With the former gear two men can swing out the boat, as with the ordinary quadrant davits, by turning the cranks, and after they have turned the boat out all they have to do is to take hold of the brake and lower away. This brake is so arranged that it gives the men, with very little effort, complete control of the lowering of the boat when it is fully loaded with passengers, as well as when empty. When it is desired to hoist the boat, this can be done by one man at each end, and by using the same cranks only that they shift the cranks to the other pinions. This gear is very simple in its construction, and is made of the best material, so as not to suffer any corrosion whatever, and it works very well.

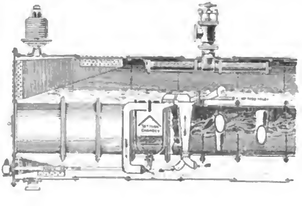
The other gear is still simpler, but is intended only for



lowering purposes, particularly on ships where wire falls are used. A great many ships nowadays carry several small winches upon the boat deck, to which the falls can readily be led when the crew wishes to hoist the boats. In such cases the simplest thing would be to apply this gear, which consists of a simple clutch brake, through which the wire is run and controlled when lowering the boat. (Welin Quadrant Davit Company, Hopetown House, London, E. C., and 17 Battery Place, New York.)

A Boiler-Water Circulator.

This device has been placed upon the market by the British Boiler Water Circulator Syndicate, of Nottingham. It is claimed not to require any structural alterations whatever to the boiler, and that it can be removed, inspected and replaced by an ordinary workman in about two hours. The object of the appliance is to increase the water circulation and facilitate steam generation by giving greater freedom to the gas-containing globules formed on the heating surfaces. It is entirely automatic in action. The feed water sent into the boiler must first pass through the apparatus illustrated, where it is not only heated, but is also cleansed and softened, while, further, the



grease is extracted. The feed inlet is indicated, and the settling chamber for impurities is also shown. The sediment, etc., can be ejected by means of a blow-off cock and pipe, and in fact the only attention necessary is that wanted for occasionally blowing out the impurities which are trapped. The construction is perfectly simple, and there are no delicate parts. The usefulness of moving water rapidly over the heated surfaces of boilers is now being recognized, and in increased steaming capacity and in the use of impure or dirty water this appliance should show advantages.

Turbine-Driven Centrifugal Hot Well Pump.

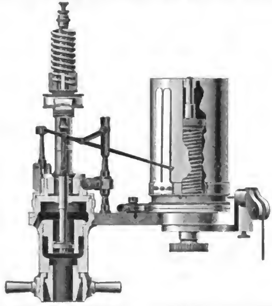
For the high vacuum required by steam turbines it has been found desirable, especially in large installations, to use separate pumps for drawing the condensed steam and the air from the condenser; forming what is known as the "dry vacuum system." The air is handled by an engine-driven reciprocating air pump, and as no water is handled the clearance can be made small, thus obtaining a high efficiency. The water is usually handled by a centrifugal hot-well pump, which is driven by an electric motor in the case of electric plants on shore, as it requires a high speed of rotation.

In using the dry vacuum system on turbine-driven vessels, it was considered objectionable to use a motor to drive the centrifugal hot-well pump, on account of the dampness and high temperature of the engine room; therefore direct drive by a steam turbine was used. The illustration shows the complete set as made by the Fore River Shipbuilding Company, Quincy, Mass., for the United States scout cruiser *Salem*, the main propelling machinery of which consists of Curtis marine turbines.

The pump end consists of a 4-inch two-stage volute centrifugal pump arranged to work with shaft vertical. The turbine is a two-stage Curtis turbine mounted above and directly connected to the pump. The entire set requires floor space of only 3 feet square, and is 9 feet 6 inches high over all. It is rated to deliver 300 gallons of water per minute from a 29-inch vacuum, and has a large overload capacity. The total weight is 5,850 pounds, and the speed is 1,200 revolutions per minute.

A New Indicator.

The Star Brass Manufacturing Company, Boston, Mass., has recently developed a new steam engine indicator of the outside spring type, which has been given severe tests, and is said to work extremely well. A number of the special features distinguishing this indicator from some of the others on the market include an elongation of the spring instead of compression; a comparative uniformity of temperature of the spring, due to its position outside the steam passages; lightness and accuracy of the spring; strength and rigidity of the pencil



motion; a good diameter and length of piston; general solidity of the indicator frame; ease of change from right to left hand, also in changing tension of drum spring; accessibility of cylinder for removal or examination; the cylinder at all times surrounded by live steam, forming a steam jacket which is self-draining; and all chance of back pressure on top of the piston removed, owing to the provision of means for the passage of exhaust steam from the cylinder to the atmosphere.

A bifurcated post is provided to guide the pencil arm, thus preventing any outward dislocation, with consequent cramping of the movement. The barrel is provided with stops engaging with lugs on the sleeve. This prevents any cramping in right and left motion. The adjustment of the atmospheric line is accomplished by means of washers on top of the barrel. The device is really a lock nut, and the position of the line is not changed by a change of spring or adjustment in any part of the instrument. It is said that eleven of these indicators are in use on the battleship *Vermont* and thirty-six in the Brooklyn Navy Yard.

Steam Turbine Lighting Set.

There have recently been placed on the market by the B. F. Sturtevant Company, Hyde Park, Mass., electric generating sets for ship lighting and kindred purposes, in which the prime mover is a steam turbine with one or more disks of vanes, all sizes below 200 horsepower being single stage, and those above, two, three and four-stage. The bucket wheel is

a single forging of open-hearth steel, with the buckets worked out of the solid metal on an automatic cutting machine. A shroud is left on the outside of the blades to insure against fouling. On either side of the bucket wheel is a stationary reverse guide ring of forged steel, as shown in one illustration. Steam nozzles of tobin bronze are inserted at *A*, and the steam, entering at these two points at the extremities of a diameter, acts upon buckets in the wheel, reacts in the reversing buckets, and returns again and again to the wheel, thus

taking a spiral path in the closed chambers or cylinders formed by the two sets of buckets. These guide buckets are shown at *B*, and the steam is exhausted at *C*. Midway between the two nozzles are small starting buckets *D*, increasing the starting torque. At full speed these are shut off.

To take a typical case, that of a unit of 50 horsepower, we find that the speed range under different conditions is from 1,600 to 3,000 revolutions per minute. The net weight of the turbine and its base, exclusive of the generator, is 2,400 pounds. The length of the turbine shaft is 44 inches, the extreme height is 50 inches, the exterior diameter of the turbine casing is 30 inches, and the base measures 35 by 32 inches over all.

TECHNICAL PUBLICATIONS.

Steam Turbines. By Carl C. Thomas, professor of marine engineering, Sibley College, Cornell University. Size, 5¾ by 9 inches. Pages, 334 + XXXII. Figures, 145. Plates, 20. New York, 1907: John Wiley & Sons. Price, $4.00. London: Chapman & Hall, Ltd. Price, 17s.

This is the third edition of the work, and includes new material on the design of the Curtis and Parsons types of turbine, as well as suggestions regarding turbine analyses and a diagram of the heat contents of steam, the superheated region of which is plotted from the results of the author's recent investigation of the specific heat of superheated steam, as presented before the American Society of Mechanical Engineers in December, 1907. The present edition contains also new material relating to the application of steam turbines to marine propulsion, including illustrations of some of the most recent turbine steamers. Only such details relating to present practice in turbine construction have been given as would suffice to illustrate the application of the principles.

Five of the ten chapters are devoted to theoretical considerations covering the subject of steam and its operation as an agent for the generation of power. This part of the subject covers nearly one-third of the text. The subject of the flow of steam through orifices, nozzles and turbine buckets is taken up as an intermediate stage between the theoretical part of the work and the practical discussion of turbines and their design. The last four chapters are devoted to descriptions of various types of turbines and their operation, including discussions of the broad classes into which turbines may be divided; while the tenth chapter is devoted to the marine steam turbine. In this chapter is a considerable amount of information regarding vessels which have been equipped with steam turbines, nearly all of them, of course, being of the Parsons type. Charts are given showing the relative economy as between turbines and reciprocating engines, and there are diagrams of engine rooms, photographs of various prominent turbine-propelled vessels, such as the *Lusitania* and the *Creole*, and many other illustrations covering the construction of the turbine and methods for measuring its action.

Introduction to the Study of Electrical Engineering. By Henry H. Norris, M. E., professor of electrical engineering, Sibley College, Cornell University. Size, 6 by 9 inches. Pages, 404 + XXIV. Figures, 179. New York, 1907: John Wiley & Sons. Price, $2.50 net. London: Chapman & Hall, Ltd. Price, 10/6 net.

The work is intended as a text-book for the use of students in electrical engineering at the higher technical colleges, and is intended to lay a foundation for more advanced analytical work by those pursuing such courses. It is designed to be used in combination with practical experience in either the construction or operation of electrical machinery, or with laboratory exercises, and as such should be sufficient to enable a student to intelligently select, install and operate machinery of this type.

The work is divided into thirteen chapters and an appendix. The chapters include, respectively: Historical Development of Electrical Engineering; Fundamental Electrical and Magnetic Quantities; Materials of Electrical Engineering; Electric Circuits; Magnetic Circuits; Construction of Electric Circuits; Operation of Electric Generators; Transformers and their Applications; Construction and Operation of Power

Stations; Electric Motors and their Applications; Electric Lighting and Heating; Electrical Measurements; the Transmission of Intelligence. The numerous illustrations are all of the line type, and nearly all of them have been made by the wax process, thus insuring splendid definition of lines and clearness in appearance.

Particularly interesting are the chapters devoted to electric generators and motors, these giving details regarding the proper operation and application of these units, and describing in some detail different types of motors and their construction. The last chapter deals with telegraphy in its various departments, including wireless telegraphy; the telautograph, designed for transmitting handwriting over a long distance; telephones, exchanges and central offices, and a short note on wireless telephony. A splendid index, covering about twenty-five pages, adds much to the value of the work.

Hints to Engineers for the Board of Trade Examinations. By W. D. Martin, M. I. E. S. Size, 4¾ by 7¼ inches. Pages, 105 + II. Figures, 35. Glasgow, 1908: James Munro & Company. Price, 2/6 net.

This little work is a collection of questions and answers on practical features connected with the operation of marine engines, boilers, pumps and auxiliaries, including a considerable amount of material upon such items as metals, gages, electricity, refrigeration, etc. The illustrations are all from line drawings, and cover, in general, indicator cards, gage glasses, various types of valves, pumps and boilers, as well as riveting. The work appears to be thoroughly practical and well adapted to its purpose. It covers simple computations and sketches as well as direct answers to questions.

Simple Problems in Marine Engineering Design (Including Turbines). By J. W. & R. M. Sothern. Size, 4¾ by 7¼ inches. Pages, 199 + XI. Glasgow, 1908: James Munro & Company. Price, 2/6 net.

This is the second edition of the work, which is divided into six sections: Simple Engineering Mathematics; General Problems; Engine Design; Boiler Design; Marine Turbine Design; Speed, Consumption and Horsepower Problems. The work is replete with rules and examples, and is intended to be used in connection with a theoretical work covering much the same subjects. With a good knowledge of the general features of the problems, however, the work is entire in itself, and would serve simply as a guide in the working out of the various features of marine engines, turbines and boilers. In each case the answer to every problem is given as a check to the work, and the total number of problems is sufficiently great to give a considerable scope in character. In many cases the problems are made more than usually specific by reference to the name of the ship under consideration.

Steam and Entropy Tables. By Cecil H. Peabody, professor of naval architecture and marine engineering, Massachusetts Institute of Technology. Size, 5¾ by 9 inches. Pages, 131 + XXIV. New York, 1907: John Wiley & Sons. Price, $1.00. London: Chapman & Hall, Ltd. Price 4/6 net.

This is the seventh edition of tables calculated twenty years ago to accompany the author's "Thermodynamics of the Steam Engine." Since that date important experimental investigations have been made, and this information has been used in recomputing the tables and in making certain changes facilitating their use. All the tables for saturated steam have columns of entropy, due to vaporization, and the table in metric units has been made into a conversion table, by aid of which properties can be found in either metric or English units, or a combination of the two may be used.

The introduction deals at some length with the properties of steam and other vapors, going into the subject from the theoretical standpoint and making use of the calculus. The first table covers saturated steam on the basis of temperature in degrees Fahrenheit. The second table covers saturated steam on the basis of pressure absolute in pounds per square inch. The third table covers saturated steam in metric and English units, based on temperatures. The next eight tables cover properties of saturated vapor of ether, alcohol, chloroform, carbon-disulphide, carbon-tetrachloride and aceton in metric units, and of ammonia and sulphur-dioxide in English units. The remaining tables include one showing the specific gravity and specific volume of liquids, one showing the volume of water at different temperatures based on its volume at 4 degrees C., conversion tables between inches of mercury and pounds per square inch, and a table of corrective factors for superheated steam.

The Temperature-Entropy table occupies fifty-two pages of the book, and is followed by tables of Naperian and common logarithms.

Les Flottes de Combat en 1908. By Commandant de Balincourt. Size, 6 by 4¾ inches. Pages, 787 + LVI. Figures, 386. Paris and Nancy, 1908: Berger-Levrault & Company. Price, 5 francs.

This is the seventh edition of a work devoted to the dissemination of information about the navies of the world. The general scheme is a left-hand page occupied by a line cut, showing an outboard profile and a battery plan of a vessel, while on the right-hand page is a description of that vessel, and, of course, at the same time, of its sister ships. The drawings show the general appearance of the ships, and the location and approximate thickness of the armor for the hull and battery. They show also the distribution of the various guns, and give a general idea as to the character of the designs from the point of view of the main elements of attack and defense. All the important ships of all the navies of the world are included, which makes the work a valuable one for reference. There is an alphabetical index at the rear.

Particularly interesting in the present number are figures of some of the latest vessels under construction. In many cases the details of these vessels are not well known, and it is possible that the real ships will show considerable changes from the drawings and descriptions here given. As indicating, however, such knowledge as is at present available on the subject, these are more than usually interesting. Among these vessels might be mentioned the four new German battleships, which carry sixteen 11-inch guns in six turrets, four of which turrets carry three guns each. These are arranged so that all may be fired on one broadside, the turrets at the ends being located as in the American battleship *Michigan*, while those amidships are placed *en echelon*. The ship is shown with two funnels. The German cruisers "*E*" and "*F*" are also illustrated, the former having ten 11-inch guns in six turrets, located like the six turrets on the American battleship *Connecticut*. There are four funnels. The armored cruiser "*F*" is shown with twelve 11-inch guns in pairs in six turrets, the arrangement of turrets being the same as in the German battleship, and allowing all of the guns to fire on one broadside. Six funnels are here shown, three forward and three aft.

Other ships, about which a certain amount of mystery has been maintained, include the new Italian battleship of 16,000 tons, which has eight 12-inch guns in pairs in four turrets, mounted one at either end of the ship, and two amidships *en echelon*. These may all be brought to bear on one broadside. Four funnels are shown, two forward and two aft. The Japanese battleship *Satsuma* is illustrated, showing a main battery of four 12-inch and twelve 10-inch guns, all mounted in pairs in turrets in the conventional manner. The new Japanese battleship *Huki* is also shown, with twelve 12-inch guns in pairs in six turrets. Four of these turrets are arranged in the same manner as in the battleship *Michigan;* the other two are located, one on either broadside, and the broadside fire is thus from ten of these guns; there are two funnels. The battleship-cruiser *Kurama* is shown, with three funnels, with a main battery of four 12-inch and eight 8-inch guns. The

former are mounted in the usual manner, while the 8-inch guns are located singly in eight turrets, four on either broadside.

QUERIES AND ANSWERS.

Questions concerning marine engineering will be answered by the Editor in this column. Each communication must bear the name and address of the writer.

Q. 392.—How much coal is used in a year by the merchant ships of the world? W. S. R.

A.—This is a subject which is exceedingly difficult of even approximate determination. Any estimate made would be subject to extreme guess work, because of the fact that marine engines differ so very markedly in general economy, particularly when viewed in respect to their widely varying sizes, designs and dates of construction. Without going pretty deeply into the matter, it would be totally impossible to arrive at any figures of even approximate exactness. Merchant ships, as a rule, operate at nearly full power, and hence are not subject to the comparatively heavy consumption of coal based upon the operation of large engines at a small fraction of their power, as in warships.

The merchant steam tonnage of the world at the present time is estimated at nearly 33,000,000 gross tons. Most of these ships are freighters with average speeds not exceeding 10 or 11 knots, which means a low proportion of horsepower. An offhand estimate of the latter might be put at 15,000,000 horsepower. This figure cannot be considered as accurate within 25 or 30 percent, but it serves at least as a basis for estimate.

Assuming that the average vessel is in service for one-half of the time, and that the coal consumption averages 2½ pounds per horsepower per hour, we have for each horsepower a total of 60 pounds of coal per day, and 183 days' steaming in the year. This makes each horsepower call for 11,000 pounds (about 5 tons) of coal per year. On this basis the total annual consumption would figure out at about 75,000,000 tons, which, we believe, is about 8 percent of the total annual coal production of the world.

Q. 393.—What is "cavitation" in a propeller? F. A. W.

A.—Cavitation is a phenomenon in water or other fluid, existent in connection with the propulsion of fast ships by screw propellers, in which the space immediately in the rear of the propeller blade is rendered more or less empty on account of the blade's rapid cleavage of the water, and the relatively slow action of the water in closing in behind the moving blade. This action breaks the continuity of the stream of water in which the propeller is acting, and renders it impossible for the propeller to develop upon the water the full effective thrust of which it would otherwise be capable. It is an unstable condition, and one which has caused much concern to designers of fast vessels.

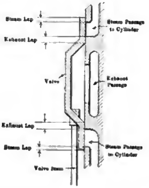
Q. 394.—How do you find the working pressure of a boiler? (2)—What is lap? What is lead? J. L. A.

A.—If the diameter of the shell, the thickness of the shell, and the character of riveting are known, we can figure the working pressure according to the formula:

$$P = \frac{T \times t}{\frac{1}{2} D \times f},$$

where T is the tensile strength of the steel of which the shell is made; t is the thickness of the boiler shell in inches; D is the diameter of the boiler in inches; and f is the factor of safety. Suppose we assume that we have material with a tensile strength of 60,000 pounds per square inch, and that the shell has a thickness of ¼ inch and a diameter of 150 inches. If we take a factor of safety of 6, we find that the allowable boiler pressure would be: $P = \frac{60{,}000 \times \frac{1}{4}}{75 \times 6} = 100$ pounds per square inch. This assumes that the longitudinal seam is single riveted. If it is double riveted, we can add 20 percent to the above figure, thus giving a boiler pressure of 120 pounds per square inch.

(2).—Lap and lead both refer to the position of a valve with regard to the steam passages of an engine in which the valve is working. These are best explained by a sketch. When the



valve surface overlaps the steam ports, the amount of this overlap is known as the "lap" of the valve. It is evident that in this case the valve must be moved through this distance before steam can be admitted to the cylinder. The lap of a valve is always measured in the middle of the stroke. On the steam edge of the valve this is called the "steam lap," and on the exhaust edge the "exhaust lap."

The amount of opening of the steam port at the moment when the piston begins its stroke is called the "lead" of the valve. This is brought about by regulating the angle between the position of the eccentric and the position of the crank. One object of this is to admit a slight amount of steam before the piston finishes its stroke, thus forming an elastic cushion against which the piston is brought gently to rest, and which then assists in reversing its motion.

Q. 396.—At about what speed should a four-cycle marine motor be run? I have been told that a propeller may be designed to fit any speed of revolution, while, on the other hand, I understand that a marine motor works best at about 600 revolutions. Does this vary with the model of the boat? Supposing that the wheel should turn about 600 revolutions, and that I have a motor which would run 1,200 revolutions, and I reduce the speed of the propeller shaft by a two-to-one gear, so that the required 600 revolutions were obtained. Am I wrong in assuming that a 10-horsepower motor, running at 1,200 revolutions, geared two to one, causing the wheel to run at 600 revolutions, would be equal to 20 horsepower, minus friction, by virtue of the two-to-one gears? Is this practical? If it is, it would certainly include a benefit in having the shaft parallel to the water line. B. B. S.

A.—The number of revolutions at which a marine engine should be run depends upon the power of the motor, and the model and speed of the boat. They may be successfully run anywhere between 200 and 1,100 revolutions, if they are well adapted to the particular circumstances of the case. It is practically impossible to design an efficient wheel for a low-speed cruising boat when the revolutions are over 500 or 600. In the high-powered, high-speed type of boat, revolutions may run as high as 1,000, but 600 revolutions is a very fair average for ordinary work.

Your scheme to obtain 20 horsepower with a 10-horsepower motor is, of course, absolutely impossible. It certainly would not have been neglected all these years if it could have been done. But you are not doubling the horsepower when you reduce the speed; you are simply doubling the acting force, but moving this force only half as fast. The horsepower, which is a product of force and speed, ought to be the same in either case, neglecting friction. Taking friction into account, you

will have less horsepower on the propeller shaft with your scheme than you will have on the crankshaft. The efficiency of gears, when well designed, ranges between 85 and 95 percent; that is, 10 horsepower at the crankshaft of your motor would give you perhaps 9 horsepower at the propeller shaft.

T. M. B.

Q. 396.—Kindly inform me how I may remedy the "grunting" in the intermediate pressure cylinder of a triple-expansion, four-cylinder marine engine, every time we get under way. The diameters of the cylinders are: H. P., 38.5; I. P., 63.5; two L. P., 74 inches each; boiler pressure is usually kept at 250 pounds. All cylinders are steam-jacketed, and we allow from 2 to 3 hours in heating up the main engines. As the revolutions are increased, this noise will decrease, until a speed of 60 R. P. M. is obtained, when it will stop altogether. Shutting the steam off of the jackets also proved to decrease this noise.

A. N. M.

A.—The "grunting" of the cylinder in getting under way is not at all unusual; for most engines grunt for 10 or 15 minutes after steam is admitted, no matter how thoroughly they may be warmed up. This is said to be due to the dryness of the cylinder walls, and a remedy is to inject a pint of water into the cylinder when it begins to grunt. This would probably stop the noise. Shutting the steam off the jackets, as mentioned, would also operate to decrease the noise, because of the fact that this permits greater cylinder condensation, the water from which tends to lubricate the cylinder walls.

C. A. M.

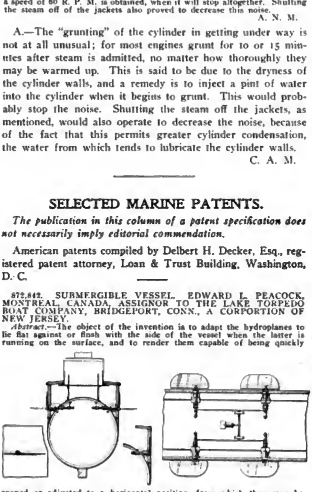
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

872,842. SUBMERGIBLE VESSEL. EDWARD L. PEACOCK, MONTREAL, CANADA, ASSIGNOR TO THE LAKE TORPEDO BOAT COMPANY, BRIDGEPORT, CONN., A CORPORTION OF NEW JERSEY.

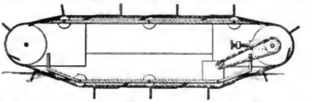
Abstract.—The object of the invention is to adapt the hydroplanes to lie flat against or flush with the side of the vessel when the latter is running on the surface, and to render them capable of being quickly



opened or adjusted to a horizontal position, from which they may be turned axially so as to present either their upper or lower surface to the water at any angle, to cause the vessel to rise or sink as the occasion requires, means being employed and operable from within the vessel for operating the hydroplanes and holding them in either position, and for adjusting them axially and holding them in their adjusted position. Sixteen claims.

872,870. BOAT. BENJAMIN F. WATERS, DOVER, N. C.

Claim.—A boat comprising a body, pulleys mounted in pairs at the ends thereof, parallel cables trained over said pulleys and transverse paddles connecting said cables, each of said paddles comprising a vertical working portion, and flexibly connected slats disposed as an



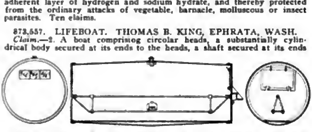
entirety in a horizontal plane, the end ones of said slats being provided with an inwardly extending inclined deflecting blade. One claim.

872,759. ELECTROLYTIC SHIP-BOTTOM PROTECTOR. JOHN H. SCHONEBERGER AND GEORGE W. FRAZIER, ALLEGHENY, PA., ASSIGNORS TO PITTSBURG ELECTROLYTIC MANUFACTURING COMPANY, A CORPORATION.

Abstract.—The invention has for its object the production and arrangement of certain electrochemically related elements whereby the electrolysis of sea water is effected continuously, and the submerged, unpainted metal of a vessel is gradually coated with a more or less adherent layer of hydrogen and sodium hydrate, and thereby protected from the ordinary attacks of vegetable, barnacle, molluscous or insect parasites. Ten claims.

873,557. LIFEBOAT. THOMAS B. KING, EPHRATA, WASH.

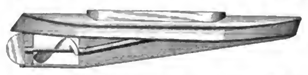
Claim.—2. A boat comprising circular heads, a substantially cylindrical body secured at its ends to the heads, a shaft secured at its ends



to the heads at points below the centers thereof, and a seat suspended from and pivotally connected to the shaft, and constituting a weight to hold the boat normally upright. Three claims.

873,614. MOTOR BOAT. VICTOR M. SALO AND JOHN RUKONEN, CHICAGO.

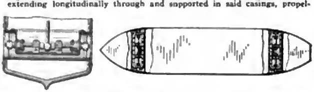
Claim.—In a motor boat, the combination consisting of a metallic fin keel tapering from the bow to a point below the propeller, and from thence parallel with the waterline to the stern, said keel having



a step to support the end of a rudder post, and opening to permit the rotation of the propeller therein, bearings to support the propeller shaft and a connecting shaft tube extending from one of said bearings diagonally upwards into the hull; a propeller shaft supported in said bearings parallel with the waterline; a propeller affixed on said shaft within the opening in said keel; and a connecting shaft in said tube connected with the propeller shaft and a motor in the boat. One claim.

873,818. STEERING VESSELS. HERMANN W. WILKE, LONG ISLAND CITY.

Claim 1.—The combination with a vessel, of transversely extending pipes at the fore and aft ends and secured to the side walls of the vessel and terminating in openings therein, the pipes being cut out at the upper surface, cylindrical casings secured to said pipes and projecting downward through the cut-out portion of the latter, crank shafts extending longitudinally through and supported in said casings, propel-



lers arranged at each end of said shafts, the propellers being adapted to draw in water at one side of the vessel and to throw it out in a jet on the other side, to steer the vessel, and means for operating said propeller shafts. Two claims.

873,899. CURRENT-SUPPLYING ARRANGEMENT. BERNHARD SALOMON, FRANKFORT-ON-THE-MAIN, GERMANY, ASSIGNOR TO FELTEN UND GUILLEAUME-LAHMEYERWERKE AKTIEN-GESELLSCHAFT, FRANKFORT-ON-THE-MAIN.

Abstract.—The invention relates to a new system of supplying electric current from a stationary conductor to ships, vehicles and the like. This system comprises a subsidiary motor-vehicle, motor-ship and the like, which is arranged to follow the conductor and to take up the current from the same by means of a slide bow or trolley, and is in turn connected with the ship, vehicle and the like to be propelled or driven by means of a conductor. Eight claims.

874,031. HULL OF VESSELS. ISAAC E. PALMER, MIDDLETOWN, CONN.

Claim.—The combination with the hull of a vessel, of wings independently movable in a vertical direction, and means for raising and lowering the said wings and for locking them in the desired adjustment, the wings being hinged one on each of the opposite sides of the keel, their shanks extending thence rearwardly along the opposite side of the

keel, and the blades of the wings gradually extending laterally as they pass under the overhanging stern of the vessel on opposite sides of the central vertical longitudinal plane thereof. One claim.

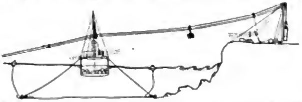
873,917. SIGNAL-BUOY. THOMAS L. WILLSON, OTTAWA, CANADA, ASSIGNOR TO UNITED STATES MARINE SIGNAL COMPANY, JERSEY CITY, A CORPORATION OF NEW JERSEY.

Claim 1.—A bellbuoy including in combination a bell, a striker, a

spring for forcing said striker toward the bell, and a cam for retrarting and suddenly releasing said spring, whereby the striker is forced toward the bell, a fixed stop to limit the forward movement of said spring before the striking movement is completed and a stop carried by the striker and adapted to compress the spring against said fixed stop by the momentum of the striker, to permit the completion of the stroke and then retract the striker. Two claims.

874,228. CONVEYING APPARATUS. THOMAS S. MILLER, SOUTH ORANGE, N. J.

Claim 1.—In combination, a traction rope extending from the shore over and beyond a vessel, an anchorage seaward of the vessel whereby



said traction rope is held distended, a load carriage operated by said traction rope and a support for said traction rope on the vessel between the load carriage and the seaward end of said traction rope. Twenty-two claims.

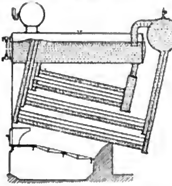
874,255. DEVICE FOR DIMINISHING THE ROLLING MOTION OF SHIPS. RUDOLF SKUTSCH, BRUNSWICK, GERMANY.

Claim 1.—A device for diminishing rolling movements of a vessel without simultaneously producing pitching movement, comprising a pair of oppositely rotatable elements mounted in swinging supports adapted to be braked, means for braking said supports whereby couples of force acting upon the vessel are provided, those of the couples which attempt to produce a pitching movement counteracting each other, thereby preventing pitching movement of the vessel. Two claims.

British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

16,816. WATERTUBE STEAM GENERATORS. H. VAN BERESTEYN, BRUSSELS, BELGIUM.

In boilers of the large tube type, arrangements are provided whereby the circulation in any one of the generating tubes is independent of that in the other tubes. The headers of the lower nest of tubes are divided into as many compartments as there are tubes. The compartments in the front header extend into the drum and terminate at the



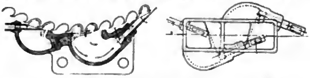
normal level. The rear header communicates above with a water drum, which is connected with the drum by a pipe. The upper nest of tubes is connected at the rear and at the front to divided headers. In a modification, a single rear header is employed for both nests of tubes. This header may be divided with a chamber at the top, common to all the compartments; or, with each compartment connected by a separate pipe with a divided chamber. In some cases, the tubes are connected directly with the drum at one or both ends.

17,191. FILTERS. H. B. WATSON AND T. C. BILLETOP, HIGH BRIDGE WORKS, NEWCASTLE-ON-TYNE.

Filtering units are formed by inclosing sponges, shavings, cocoanut fiber, etc., between flat perforated plates connected together in pairs. In one form of apparatus, the units are held in grooves formed in the side of the casing and in a partition. The liquid entering from the branch passes through one or other of the units to the compartments, and leaves through the valve. The inlet valve also controls the by-pass passage. A thin lid transmits the pressure of the cover to hold the units down in position. In modifications, only two units are used, the units in one case being curved around a central discharge compartment. In a further modification, the grids are arranged in inner and outer sets, with the filtering material between them. The upper portions of the grids are not perforated, but are left plain to prevent the passage of unfiltered water, due to settling of the filtering material.

16,874. IMPACT WHEEL TURBINES. N. BECKER, FRANKFURT-AM-MAIN, GERMANY.

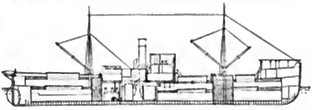
Steam is emitted from the nozzle, rebounds from the buckets into a bowl-shaped cell, from whence it is again directed to the buckets by another nozzle, and so on. The nozzles are inclined both to the tangent to



the periphery of the wheel, and to the plane of revolution of the wheel. The former inclinations are equal. The latter inclinations increase as the expansion progresses.

17,279. SHIPS' TANKS. L. A. LAMMERTS AND A. D. F. W. LICHTENBELT, ROTTERDAM, HOLLAND.

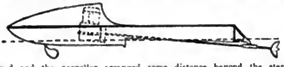
In the event of a collision, stranding, or other accident, water is discharged from closed waterballast tanks by means of compressed air, in order to increase the buoyancy of the ship, or of one end of it, as



required. On operating a three-way cock on the bridge, one tank is placed in communication with the atmosphere, and water flows out through pipes until the level in the tank is the same as that of the water outside the ship, a whistle being sounded by the air drawn through. When the whistle ceases to sound, the cock is moved to the second position, and compressed air from two of three reservoir tanks forces the remaining water from the first tank. The reservoirs are supplied with air by means of an airpump, and the air pressure is indicated by a gage on bridge. Airtight compartments under each deck are formed by horizontal and vertical plates, and are filled with displaceable water or supplied continuously with compressed air.

17,360. BOATS' HULLS. A. E. KNIGHT, LONDON, S. W.

The lower surface of the afterbody of a navigable vessel is in a distinctly different plane from that of the forebody. The surface may be flat or somewhat concave in cross section. The propeller shaft is inclined and the propeller arranged some distance beyond the stern. The forebody is of ordinary construction. When the vessel is traveling, the afterbody is lifted more or less out of the water, and a film of air is contained between the surface of the vessel and the water surface.

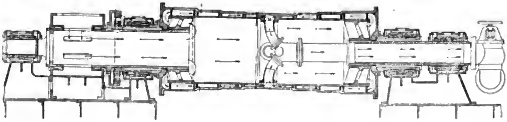


18,095. WATERTUBE STEAM GENERATORS. W. J. PARKYN, T. BRADLEY AND J. GRESTY, Engineering Works, Dukinfield.

According to the present invention, the various pipe connections are made with detachable joints. Flanged joints are shown, but screwed nipples or the like may be employed. Hot water, taken either from the outlet end of the feedheater or the drum, is mixed with the cold feed before it enters the heater. The hot water may be supplied to the suction side of the feed pump by small pipes. The boiler casing is preferably lined with suitable material, such as fire-tiles, in which passages for heating the air supply to the ashpit and above the fire are formed.

17,590. ELASTIC FLUID TURBINES. R. W. PATTERSON, PARTICK, AND R. P. RAMSAY, SCOTSTOUN.

Relates to multi-stage steam turbines in which the two elements rotate in opposite directions. The inner element is supported by two perforated disks mounted on hollow shafts rotating in bearings. The outer element is supported by bearings, and is coupled to a gear wheel which gears with a wheel on the inner element through pinions. Steam is supplied to the annulus by pipes connected to a pipe passing through the hollow shaft, and is exhausted through the opposite trunnion by way of ports, part of the steam having passed through the interior of the inner element.



International Marine Engineering

APRIL, 1908.

THE FAST STEAMER FLORIDA.

BY GEORGE JENKINS AND A. E. WOODRUFF.

The *Florida* is the latest addition to the fleet of steamers of the Baltimore Steam Packet which run between Baltimore and Norfolk, and is said to be the finest and fastest vessel on Chesapeake Bay. She was built by the Maryland Steel Company, at Sparrows Point; is handsomely fitted out with passenger accommodation; contains 136 staterooms, and is the largest passenger vessel south of New York City.

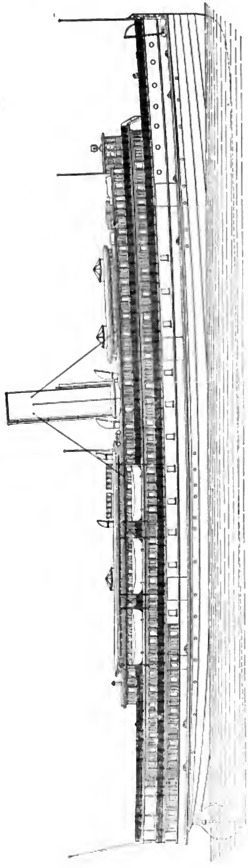
The *Florida* in construction and appearance is similar to the steamer *Virginia* of the same line, with the exception of the gallery deck, which extends the full length of the ship, and gives her thirty more staterooms. Her center keelson is 45 inches by 25 pounds and is connected to the frames by 22½-pound floors, reduced at ends. Under the engines the floors are 41 inches deep at the forward end, tapering aft to

THE INTERIOR DECORATION OF THE FLORIDA, AS TYPIFIED IN THE MAIN SALOON AND GALLERY.

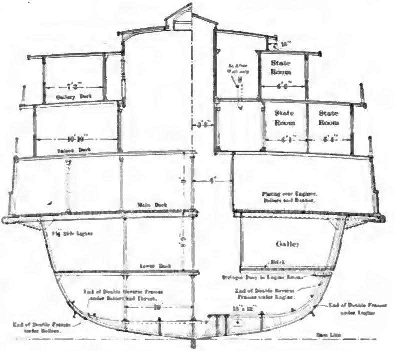
Her principal dimensions are:

Length over all	306 feet
Length between perpendiculars	296 feet 2 inches
Beam molded at waterline	41 feet
Beam molded at deck	45 feet
Beam over guards	66 feet
Depth molded	18 feet
Draft, mean	11 feet
Draft, forward	9 feet
Draft, aft	13 feet
Gross tonnage	2,200

follow the center line of the shaft. She is framed with angles 4 by 3 inches by 9.8 to 8.5 pounds, doubled at the forward end to give strength and protection for running in ice. In the engine space there is a belt on every frame to main deck; elsewhere, on every tenth frame. Her main deck beams are 9 by 3½ inches by 27 pounds, bulb angles, on alternate frames, and the lower deck beams are 5 by 3 inches by 9.8 pounds on every frame. Her main deck stringer is 50 inches by 22½ pounds, and the sheer strake is 27½ pounds, both reduced at ends. Seven watertight bulkheads running from the keel to the main deck divide the hull into eight watertight



OUTBOARD PROFILE OF THE NEW STEAMER FLORIDA, BUILT BY THE MARYLAND STEEL COMPANY.



MIDSHIP SECTION OF THE FLORIDA, WITH DETAILS OF UPPER WORKS.

compartments. Her scantling is a little in excess of the requirements of the United States Register for steel vessels, which gave her a rating of "A No. 1" for twenty years.

While some attention has been paid to speed, the greatest care has been bestowed upon the comfort and safety of passengers, and, being in excess of the rules, she is sufficiently strong to do her work with ease. This idea has been followed, because in practice it is not only economical, on account of small wear, but very durable, and also produces a vessel almost entirely void of vibration.

Besides 136 staterooms, there are accommodations for thirteen second-cabin men and fifteen second-cabin women on the lower deck forward. On the same deck is the dining room, finished in oak of an elaborate design, artistically decorated, and with a seating capacity for fifty-six passengers at one time.

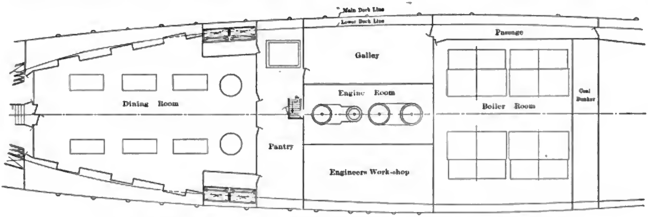
The main deck is chiefly for cargo and baggage, except the saloon aft, this being finished in quartered oak, and the social hall, which is finished in mahogany. The main gallery saloons are tastefully finished in soft wood and mahogany, the decorations being white and gold. One of the features of the *Florida* will be the domes in the gallery deck, which will be glazed with cathedral glass.

Interlocking rubber tiling is laid in the social hall, dining room, stairways and wash rooms. The staterooms are finished with velvet moquette carpets, all of the rooms having individual heat, light and electric bells, and the larger rooms having brass bedsteads.

MACHINERY.

The machinery consists of one four-cylinder, triple expansion engine, four single-ended Scotch boilers, a donkey boiler, an electric set and other auxiliary machinery. The main engine developed, on trial, 2,550 indicated horsepower on 105 revolutions per minute, with 175 pounds steam pressure, driving the boat at 17½ knots speed.

The two low-pressure cylinders are placed forward of the high-pressure cylinder, and the intermediate cylinder aft. This arrangement of cylinders was made for balancing purposes, and as the *Florida* has a night run entirely, it is

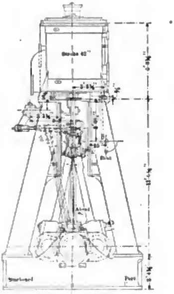


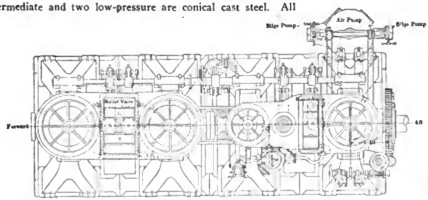
PLAN OF A PORTION OF THE LOWER DECK OF THE FLORIDA, SHOWING GENERAL ARRANGEMENT OF MACHINERY SPACES.

imperative that the engine should be as nearly balanced as possible.

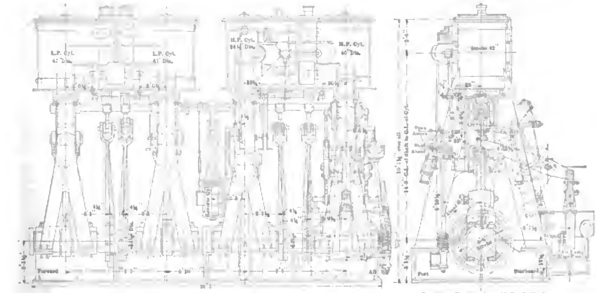
The high-pressure cylinder is fitted with a working liner of cast iron, and has an 11½-inch piston valve. The intermediate cylinder is fitted with a double ported slide valve, and the two low-pressure cylinders have double ported slide valves working in a common chamber.

The high-pressure piston is a solid iron casting; but the intermediate and two low-pressure are conical cast steel. All





Looking Aft on L.P. Cylinders



Looking Forward on M.P. Cylinder

FLAN AND LONGITUDINAL AND END ELEVATIONS OF THE FOUR-CYLINDER TRIPLE-EXPANSION ENGINE OF THE FLORIDA.

pistons have cast iron spring rings. The piston rods are of wrought steel, the low-pressure rods being 4½ inches in diameter, and the others 5 inches in diameter.

The connecting rods are of the strap-end type, with brass boxes top and bottom; the low-pressure rods being lighter than the others. The high-pressure and intermediate cross-head pins are 7 inches in diameter by 7⅛ inches long; the low-pressure cross-head pins are 6 inches in diameter by 6¾ inches long. The cross-heads are of wrought steel, fitted to double cast-iron slippers faced with white metal.

Each cylinder is supported by two hollow, cast-iron columns, each having a hollow cross-head guide bolted to it. The bed plate is in four sections, with facing to receive the main bearing boxes. These boxes are made of hard brass, lined with white metal and secured by wrought-steel binders and bolts.

The valve gear is of the Stephenson link type, having wrought steel strap end, eccentric rods and drag links, steel links, pins, cast iron eccentric and straps, and brass eccentric rod boxes, drag link boxes and link blocks.

The reversing gear is a steam ram, 14 inches diameter by 24 inches stroke, secured to the after side of the high-pressure back column. The reverse shaft is in two parts, of wrought steel, with wrought steel arms. A 5 by 5-inch double-cylinder turning engine is secured to the forward side of the intermediate front column, and connected to the crankshaft by worm and wheel.

An air pump and two bilge pumps are worked from the intermediate cross-head. The air pump is 30 inches diameter by 14 inches stroke; and the bilge pumps are 4 inches diameter by 14 inches stroke.

The crankshaft is of the built-up type, in two sections, of fluid compressed steel, 13½ inches in diameter. The crankpins are 13¾ inches in diameter by 12 inches long. The thrust shaft is 13½ inches diameter, of fluid compressed steel, with six collars forged on. The thrust is taken on cast iron horseshoes faced with white metal. These horseshoes are held in place by brass nuts on bronze rods, permitting an independent or collective adjustment of the horseshoes. All the line shafting is 13¼ inches; and the propeller shaft is 13½ inches in diameter, covered the entire length of the stern tube by brass sleeves.

The propeller is of the built-up type, with cast iron hub and composition blades. It is 12 feet 9 inches diameter, with a pitch adjustable from 18 feet 3 inches to 19 feet 3 inches (pitch ratio, 1.43 to 1.51).

The condenser is independent of the main engine, having a cast iron circular body, and containing about 3,700 square feet of cooling surface. The circulating pump is from the Kingsford Machine Company, having 12-inch suction, and driven by a vertical 9 by 9-inch engine. A 36-inch Reilly feed heater has been installed; and two 25-kilowatt General Electric direct-connected, multi-polar dynamos have also been fitted.

All pumps are of the Warren horizontal duplex type, and consist of the following: One feed pump, 12 by 7 by 12 inches; one donkey pump, 12 by 7 by 12 inches; one sanitary pump, 6 by 5¼ by 6 inches; one fresh water pump, 4½ by 3¾ by 4 inches, and one heater drain pump, 4½ by 2¾ by 4 inches.

There are four main boilers and one donkey boiler, having a working pressure of 175 pounds per square inch. The main boilers are of the single-ended Scotch type, 13 feet 2 inches mean diameter by 11 feet 3 inches long, having a total grate surface of 286 square feet, and total heating surface of 7,100 square feet (ratio 24.8 to 1). Each boiler contains three 44-inch corrugated Morison suspension furnaces, with a common combustion chamber. The donkey boiler is a return tubular dry-back, 7 feet 3 inches diameter by 6 feet long, containing one 44-inch Morison furnace. All pipe connections are copper or brass, making the machinery, as well as the hullwork, strong and durable.

THE NEW STEAMER FLORIDA, OF THE BALTIMORE STEAM PACKET COMPANY.

An Improved Winch.

An invention which is expected to have an important future has recently been made in Liverpool. The innovation in the winch consists in the adaptation of a sprocket and chain in place of the cog. It is said that this is the first time such a device has been applied to a steam winch. The main point seems to be a very marked decrease in the noise of operation. It is said that when lifting considerable weights there was a sort of rumble like that of a motor car, but a total absence of the nerve-racking rattle and crash associated with the operation of the ordinary steam winch. The driving chains were adjusted to a breaking strain of 15 tons, which is not far different from the shearing strains of the ordinary tooth-wheeled gear. It is said that the chains offer very great facilities for repair in case of necessity, particularly in comparison with the difficulty of repair to the ordinary type of winch.

THE HEATING AND VENTILATING OF SHIPS.

BY SYDNEY F. WALKER, M. I. E. E.

HEATING BY STEAM.

The arrangements for heating by steam are practically the same as those for reheating by hot water, with a few modifications, due to the difference between the flow of steam and hot water, and to the necessity for draining the condensed steam out of the heating appliances. The source of heat may be the same as with hot water, but arranged, where it is a boiler, to generate steam at low pressure, instead of merely to heat the water. On board ship, steam from the boilers is usually employed, reduced to the required pressure by one of the well-known forms of reducing valve. On shore, pressures of about 5 pounds per square inch gage are employed, and from that downwards. A very favorite form of heating is by exhaust steam, at below atmospheric pressure. As marine engineers hardly need reminding, the volume of steam and its latent heat per pound increase rapidly at pressures below the atmosphere, and in some forms of steam heating, pressures as low as 1 pound absolute per square inch, or even less, are employed. On board ship, pressures of from 15 to 25 pounds are more frequent, because of the inconvenience of reducing to much lower pressures.

Heating by steam also differs from heating by hot water, in the temperature of the heating appliance. Thus, with 15 pounds gage pressure the temperature of steam is about 250° F.; at 5 pounds gage pressure it is 228° F.; while, as explained, the usual temperature of the hot water employed in heating appliances is in the neighborhood of 170° F. With exhaust steam below atmospheric pressure, practically the same temperatures are obtainable as with hot water, and that is another advantage in its favor, apart from its economy. The temperature of steam at 6 pounds absolute is 170° F., and the latent heat is 994.7 B. T. U. per pound; while at 15 pounds gage pressure it is only 938 units, and at 25 pounds gage pressure only 926. The higher temperatures of the heating appliances are in favor of the liberation of a larger quantity of heat per square foot of the heating appliances per hour, because of the larger difference of temperature between the surface of the heating appliance and that of the surrounding air, and again because of the peculiar feature mentioned above of the rapid increase of the rate at which heat is liberated, as the difference of temperature increases.

On the other hand, however, there are grave objections to heating by steam, and those objections have led to the adoption of hot water heating appliances on shore to a very much larger extent than steam heating. The objections are that the steam heating appliances are not so easily controlled as the hot water appliances, and also there is the constant danger of the temperature of the heating appliance rising to a figure which causes it to produce a smell, referred to by heating engineers usually as that of burnt air. It is probable that this is largely burnt dust. There is also probably some action going on between the highly heated surface of the radiator and the air, that is not present with lower temperatures. Where the temperature of the heating apparatus is maintained at about that of boiling water, at ordinary atmospheric pressures, steam heating appliances have presented no difficulty whatever, but steam pressures are sometimes not easily controlled. Where a number of appliances are worked from the same source of heat, and the supply of steam is shut off to any considerable portion of them, unless the supply at the source is also reduced, marine engineers will hardly need reminding, the pressure of the steam—and therefore its temperature—in the remaining portion will rise, and the results mentioned will be produced.

The heating appliances used with steam heating are the same as for hot water heating. In fact, many makers list their

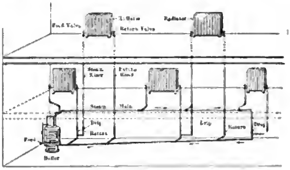


FIG. 16.—TWO-PIPE SYSTEM, LOW-PRESSURE STEAM.

radiators as applicable for steam or hot water. Pipes, of course, can also be used for steam or hot water, providing the sizes are in accordance. One or two points of difference have to be noted between the treatment of the two systems. With hot water distribution systems, the pipes are sloped where they are out of the vertical, so that the water will drain towards the boiler. With steam the pipes are sloped in the opposite direction, in order that any condensed water that is formed may be carried with the steam in the direction in which it is going, and may be driven out by the valve provided for it. Air is lighter than water, and therefore, as was explained, air cocks are to be fitted at the highest points of the service and at the tops of radiators. Air is heavier than steam, and therefore works its way downwards, and air cocks are therefore fitted at the bottom portion of radiators and in similar positions.

There are practically two systems of distribution of steam to the heating appliances, known respectively as the two-pipe and the single-pipe systems. In the two-pipe system the steam is carried to the radiator, and, with the condensed water that is formed, is carried away to some receptacle, from which it is pumped to the boiler, hot wells, etc. On the one-pipe system the steam is merely delivered to the radiator, and the condensed water that is formed is carried off from the radiator with the air that is driven out. Figs. 16 and 17 show the two-pipe and one-pipe systems as usually arranged. It is usual with steam systems to have lines of air pipes connected to the radiators, delivering the air that may have worked into the system with the steam, and that has to be driven out. This air is forced by the pressure of the steam out of the radiator through the air lines and discharged at a point where it will be harmless. Where exhaust steam is employed, it is usual to employ also a vacuum pump on the return pipes of the system, to bring the condensed steam and air back from the radiators.

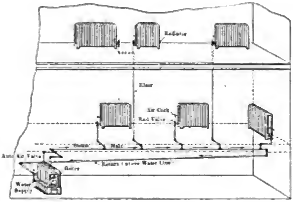


FIG. 17.—ONE-PIPE CIRCUIT SYSTEM, LOW-PRESSURE STEAM.

KORTING'S LOW-PRESSURE STEAM-HEATING APPARATUS.

Messrs. Korting Brothers, of Germany, who have made a close study of heating apparatus generally, have worked out a special system of low-pressure steam heating, which will be described. The steam is generated in a special boiler at a pressure not exceeding 1½ pounds per square inch, but presumably ordinary steam can be employed, providing that the reducing valve is arranged to lower the pressure to that figure. The very low pressure of operation is provided to meet the objection mentioned above, to the smell that sometimes arises from steam-heating apparatus, owing to the burnt dirt and burnt air with apparatus at high temperatures. A diagram of this is shown in Fig. 18.

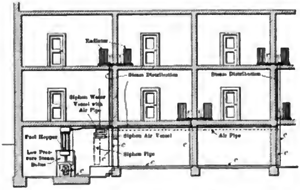


FIG. 18.—KORTING'S LOW-PRESSURE STEAM-HEATING SYSTEM AS APPLIED TO A HOUSE.

c, Return Pipes for Water. *v*, Steam Admission Valves.

For use with exhaust steam, an apparatus is employed in which the reducing valve is controlled by a lever, operated by a float working against a spring, the position of the float in the vessel being regulated by the pressure of the steam supply. When the pressure of the steam supply rises, the water in the vessel in which the float moves is driven downwards through the pipe at the bottom into another vessel at the side, whose position can be adjusted, the float then falling and partially closing the valve; the reverse operation taking place if the steam pressure falls. Where steam is supplied from the special boiler, the draft of the furnace is controlled by the temperature of the steam; a slight increase of temperature partially closing the furnace damper, and vice versa. It is doubtful whether, under ordinary conditions of sea-going ships, such apparatus would be desirable, but in sailing ships and in yachts, and in some classes of ships, such as whalers, sealers, etc., where the travel of the ship at times is not great, it might be convenient to have an apparatus of this kind.

A COMBINED AIR AND STEAM RADIATOR.

Messrs. Korting have also introduced a radiator, in which the steam is cooled by the presence of a certain quantity of air. Steam, it will be remembered, unless it is supplied below atmospheric pressure, must be at or above 212° F., and this is a somewhat high temperature under certain conditions. The temperature may be lowered by employing the partial vacuum method, but it is also claimed by Messrs. Korting that it is lowered in their special radiators by the addition of air.

The radiator is of the usual form, with a steam pipe running along the bottom of the sections, and at each section a steam nozzle enters the pipe. The admission of steam is controlled by the valve at the entrance to the radiator, in the usual way, and the steam passing out of the nozzle is allowed to draw air in with it, on the well-known injector principle. It is claimed that the steam mixes with the air, the former being cooled thereby, and the outside temperature of the radiator being consequently lowered, the air and steam circulating together, and the condensed steam being drawn off in the usual way.

(*To be continued.*)

The Relative Values of Warships.

BY C. T. BRADY, JR.

Whenever there is a prospect of war (or a newspaper prospect of one), or any unusual naval demonstration, some one is sure to make a paper comparison of the ships concerned. Sometimes these are interesting, but usually so many points are not taken into account, or else are so improperly weighted, as to be nearly worthless. Evidently some rational method would be useful. At the outset it may be clearly stated that such comparisons can be made only by a disinterested naval expert, with any hope of approximation, and also that no formula can be relied upon to do it very closely.

Still, to paraphrase M. de Voltaire, most of us are "neither disinterested, nor naval, nor experts," and yet we may be curious as to the strength of two opposing vessels. It is, then, the writer's purpose to derive here a formula which he has used with considerable interest in many cases, and found to agree very fairly well with results given by an English naval* authority's system of arbitrarily assigned values, with the *Dreadnought* as a unit.

First, we must state the requirements our formula is expected to fulfil. It must be simple and easy for a layman to apply; it must take into account as many of the features of the ship as possible; it must require no data usually not given in a newspaper description of the ship; and finally, it will be useful to have the value of the formula equal to 10, for a perfect or ideal vessel. The effect of four main characteristics will be considered, and there will be four terms in our formula, to be added together to give what may be called the fighting value of the vessel in question.

Nowadays we are coming to the conclusion that the primary aim of the fighting ship is to fight, and that fighting power is gained chiefly from large guns and plenty of them. From present tendencies, a battery of twelve 12-inch guns is none too high to be considered as ideal. Now it seems to the writer that at least 40 percent of a ship's value for warfare lies in her battery; hence if 10 is to be the total value of the type ship, 40 percent of 10 will be 4; and if we divide the ideal number of 12-inch guns by 3 we get 4. Accordingly, the first term of the formula is "the number, or equivalent number, of 12-inch guns, divided by 3." The equivalent number of guns can be readily taken from the appended curve, the data for the plotting of which was taken as follows: Fifteen 5-inch, nine 6-inch, six 7-inch, four 8-inch, two and one-half 9-inch, and one and one-half 10-inch guns, are equivalent to one 12-inch. These represent the number of guns of the lesser calibers which, in one discharge, will produce the same muzzle energy as one 12-inch. It is impossible to compare guns of different sizes in any way with accuracy, but this method is a fairly logical one, at least.

The second term of our formula is "the displacement in units of 10,000 tons." Many qualities, some of them intangible to rule, depend on the size of a ship. Steadiness of platform in a seaway, ability to keep the sea in times of storm, the amount of stores and ammunition carried, and finally the radius of action, are direct functions of the displacement. Twenty-five thousand tons is what we might expect for our ideal ship, and it would represent 2.5 or 25 percent in the ship's value.

* F. T. Jane: *Fighting Ships.*

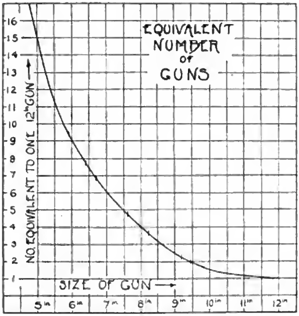


DIAGRAM ILLUSTRATING RELATIVE MUZZLE ENERGIES OF NAVAL GUNS.

Speed is of great importance in modern tactics. It seems, too, that the relative speed is not so important as the actual difference in knots. The third term of the formula is "the speed in knots, minus 15, and divided by 5." If our perfect type have a speed of 25 knots, this will represent 2, or 20 percent in the formula.

Adding together 4, 2.5 and 2, we have 8.5 so far for the value of the ideal ship; hence our last term, to bring this value to 10, must be 1.5. Now, 12 inches of belt armor is a good standard, and if we divide this by 8 we get 1.5. The last term is, then, "the thickness of armor on the belt, divided by 8."

Since ships deteriorate rapidly with age, and because of the advance in the quality of guns and armor, it will be logical to take only 0.7 of the formula value for ships launched between 1893 and 1900, and only 0.5 for those launched between 1885 and 1893. Ships built before 1885 will not be worth considering.

All this sounds very complicated, but the application is very simple. Symbolized, we have as follows:

Ship.	Nation.	Launched.	Guns (a)	Tons (b)	Speed (c)	Armor.	F. V.
Michigan	U. S. A.	1908	8.0	1.6	3.5	11.	6.4
Connecticut	"	1904	8.0	1.6	3.	11.	6.3
Georgia	"	1904	7.3	1.5	4.	11.	6.1
Maine	"	1901	5.8	1.2	3.	11.	5.2
Mississippi	"	1905	7.3	1.3	2.	9.	5.2
Alabama	"	1898	5.6	1.2	1.	16.5	3.8
Kearsarge	"	1898	6.0	1.2	1.	16.5	3.9
Iowa	"	1896	6.0	1.1	1.5	14.	3.6
Oregon	"	1893	6.4	1.1	1.	18.	2.8
Kashima	Japan	1905	8.0	1.6	3.	9.	6.0
Mikasa	"	1900	5.6	1.5	3.	14.	4.4
Tsukuba	"	1905	5.5	1.6	5.5	7.	5.4
Dreadnought	England	1906	10.0	1.8	5.5	11.	7.6
King Edward VII	"	1903	7.1	1.6	3.5	9.	5.6
Inflexible	"	1907	8.0	1.7	10.	7.	7.2
Danton	France	1908	10.0	1.8	4.	11.	7.3
Republique	"	1902	7.0	1.5	3.	11.	5.6
Deutschland	Germany	1904	5.3	1.3	3.	9.4	4.9
Regina Elena	Italy	1904	5.0	1.25	7.	9.8	5.5
*Washington**	U. S. A.	1905	4.5	1.5	7.	5.	5.0
*California**	"	1904	2.6	1.3	7.	6.	4.3
*Black Prince**	England	1904	4.1	1.4	7.	6.	4.9
*Renan**	France	1906	2.6	1.4	8.5	6.7	4.8

* Armored cruisers; others are battleships. (a) Equivalent number of 12-inch guns. (b) Units of 10,000. (c) Excess over 15 knots.

$$FV = \frac{\text{12-inch guns}}{3} + \frac{\text{Displ.}}{10{,}000} + \frac{\text{Speed} - 15}{5} + \frac{\text{Belt armor}}{8}$$

The table gives values for typical ships by this formula. They are believed to be quite approximate in the majority of cases. In any event it is the first published attempt, so far as the author knows, which will aid the non-technical person in "guessing" at the values of two contrasted ships. The reader may hesitate to use it, through fancied difficulty, but if he will only try it on the first interesting case at hand, its essential simplicity will be apparent. To show the speed with which it may be applied, the writer may state that the table took him just one-half hour to complete.

EDITOR'S NOTE.—Whatever scheme is put forward for the determination of approximate relative values of warships, there are always flaws, more or less glaring, which can be picked in it, and, as a general rule, the simpler the formula, the more glaring are the flaws. Without detracting in any sense from the value of the above method for such computations, a few points might be mentioned which would indicate somewhat the character of these flaws, and the points in which all such methods are more or less deficient.

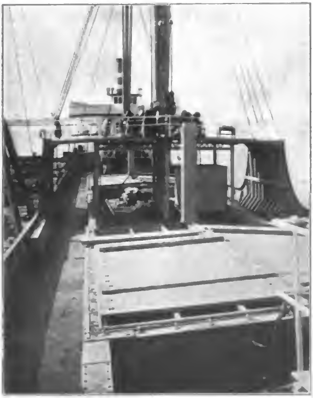
In the first place, a casual inspection determines the fact that the entire formula is empirical, the different military features being arbitrarily assigned values which may or may not meet the ideas of other investigators in the same field. Another point to which exception might be taken is in the distribution of relative values to the different guns. In the present case, these values vary about as the weights of projectiles fired from these guns. Some might object to this on the ground that it does not take due account of the greater rapidity of fire of the smaller guns; others might take the opposite view, and declare that it does not take into proper consideration the relatively much superior power of the heavier guns at long battle ranges. By taking the median position, as has been done above, the best general results have probably been attained, especially in view of the fact that great simplicity and ease of operation were prime requisites.

The question of armor is one which would probably cause more dissension than in the other cases above cited. In the present formula the maximum thickness of the waterline belt is all that is used, and a short, narrow belt thus receives the same approximate military value as would a belt of double its length and width. Here, again, the question of simplicity obtrudes itself, and points to the desirability of using the formula as given, instead of attempting to further complicate it by taking account of more items. The quality of the armor is not taken account of in any way, except in the general coefficient depending upon the age of the ship. This, again, is only roughly approximate, but it is exceedingly easy of application, and as such commends itself to consideration.

In considering the question of battery, it is usually held by naval strategists, their views being based upon all the naval engagements of the Spanish-American and Russo-Japanese wars, that the broadside fire of a ship is bound, in the future, to be that which will be most in use under all conditions of service. Bow fire is available only in contingencies, and almost never in ordinary fleet formations; for this reason, it might be suggested, that for the total guns of a given ship, there should be substituted, in the formula, simply those which can be brought to bear upon one broadside. In many cases this would make little difference with the relative values of ships; but it might be mentioned in passing that it would bring the battery figure of the *Michigan*, with eight 12-inch guns all firing on one broadside, up to that of the *Dreadnought*, which has ten 12-inch guns, of which only eight can be brought to bear on one broadside.

STEAM LUMBER SCHOONERS FOR THE PACIFIC COAST.

There have just been built by the Newport News Shipbuilding & Dry Dock Company, on plans and specifications prepared by Edward S. Hough, of San Francisco, two steam schooners of unique design, intended for service in the transport of lumber along the Pacific coast of the United States. One of these schooners, the *George W. Fenwick*, was built to the order of the Hammond Lumber Company, while the *Nann Smith* was built for the C. A. Smith Timber Company. In general features the two vessels are exactly similar, but certain differences will be noted later.

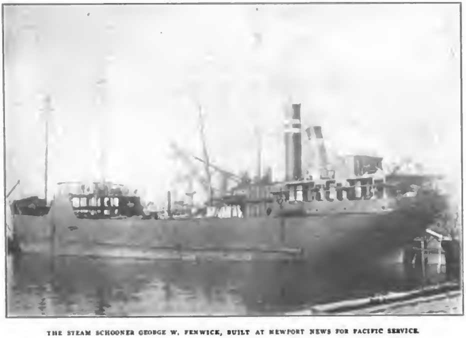


DECK VIEW, LOOKING AFT, ON THE NANN SMITH.

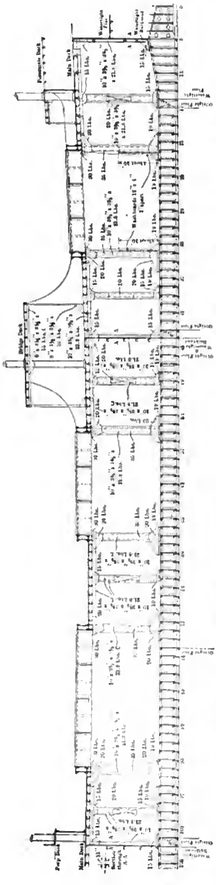
In each case the length over all is 295 feet 6 inches; the length under Bureau Veritas classification is 283 feet; the length between perpendiculars is 276 feet; the molded beam and depth are, respectively, 43 and 21 feet, with a double bottom 4 feet 6 inches deep at the center line, and 4 feet 3 inches molded at the sides. In each case poop and forecastle have been fitted with a height of 7 feet 6 inches, while the bridge has a height of 14 feet 6 inches above the main deck. The propelling machinery is at the extreme stern.

The vessels are built on the deep frame principle, so as to allow the lumber to lay up close and to avoid broken stowage. The double bottoms are of extra depth, and are made oil-tight, in order that fuel and freight oil may be carried. The tank top forward is raised 30 inches, in order to obtain continuity of strength. The forward hold above the tank top is arranged for the carrying of oil as water ballast, arrangements being made for shifting swash boards, which may be easily installed and removed. This feature is unusual in sea-going practice, although loose water ballast has been known for some time on the Great Lakes. It was adopted in this case because the two vessels will usually make the northward trip light, against frequently heavy winds and seas, which would cause distress on the comparatively flat bottom unless a sufficient immersion were provided to prevent pounding. For a distance of 50 feet from the stem the intercostal work of the double bottom has been made extra strong on this account. The keel plate is very wide and is treble riveted for the full length.

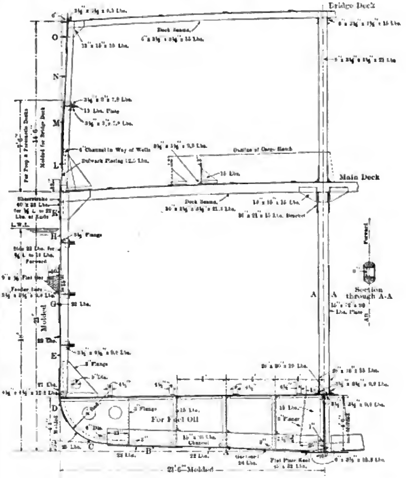
The cargo hatches are very much longer and wider than in the case of previous vessels on the Pacific coast. The decks are provided with continuous girders fore and aft, being of single plate between the hatches and box girders abreast the hatches. This arrangement gives great strength and first class compensation. The *Smith* has eight cargo winches for two hatches, while the *Fenwick* has only six for three hatches. All have been particularly designed for handling lumber.



THE STEAM SCHOONER GEORGE W. FENWICK, BUILT AT NEWPORT NEWS FOR PACIFIC SERVICE.



PARTIAL INBOARD PROFILE OF THE GEORGE W. FENWICK, SHOWING DETAILS OF CONSTRUCTION, PILLARS, BRACKETS AND BEAMS, AND OILTIGHT AND WATERTIGHT DIVISIONS.



MIDSHIP SECTION OF THE STEAM SCHOONERS, SHOWING SCANTLING DETAILS.

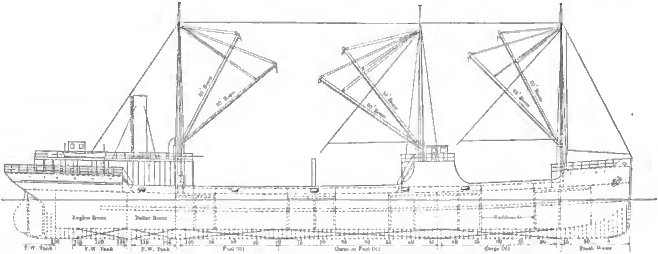
Both vessels are fitted with oil-burning systems, including two methods of atomizing the oil, one being by compressed air and the other by steam. The air pressure is 20 pounds per square inch.

The vessels are designed to carry about 2,250,000 board feet of lumber, weighing from 3 to 3.4 pounds per square foot, 1 inch thick. Assuming the average as 3.2 pounds, this makes a cargo of 3,213 tons. With this cargo, and with 2,000 barrels of fuel oil in the double bottom, the draft is 18 feet.

THE HULL.

The flat plate keel is 45 inches and of 32 pounds steel amidships. The garboard, bottom, bilge and side plates up to the main deck amidships vary from 22 to 27 pounds, with a sheer strake of 33 pounds, 40 inches wide. Above the sheer is bulwark plating of 12½ pounds, except in way of poop, forecastle and bridge deck. In the poop 14-pound plates are carried up the additional 7 feet 6 inches, while on the forecastle deck these plates are 16½ pounds; for the bridge deck, 14-pound plates are carried up over the 14 feet 6 inches above the molded main deck.

The solid continuous center line keelson is of 20½-pound steel, with double angles running along the top and bottom, and with angle clips joining it to the floors. Three side keelsons on each side, distant respectively 4 feet, 8 feet and 12 feet from the center line, consist of 15-pound plates fastened to the floors, the tank top plating and the transverse channel frames by angles measuring 3 by 3 inches by 7.2 pounds. The channel frame in the double bottom extends to the lower turn of the bilge and measures 15 inches by 33 pounds. It is

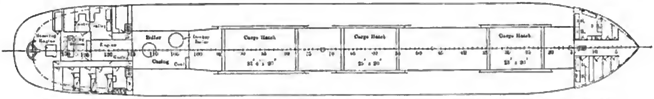


OUTBOARD AND PARTIAL INBOARD PROFILE OF THE GEORGE W. FENWICK, SHOWING OIL STORAGE, BOOMS, AND UNEQUALLY-SPACED MASTS.

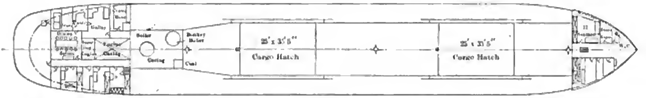
pierced in each compartment for 3-inch limber holes. At the ends are angle frames, 3½ by 3½ inches by 9.8 pounds. The bracket floors, which are located on every frame, are of 15-pound steel, with occasional lightening holes 12 inches in diameter. At the forward end the floors are 16½ pounds, and in the engine room 22 pounds. Around the turn of the bilge the outer edges of the floors are stiffened by short angle frames, 3½ by 3½ inches by 9.8 pounds. The bilge amidships is formed by the arc of a circle with a radius of 4 feet.

The inner bottom plating includes a center plate 19 pounds in the holds and 21½ pounds in the machinery space, with other strakes 14 pounds in the holds and 17½ pounds in the machinery space. The margin plates in the holds are 16½ pounds. This plating is connected to the floors by means of single angles measuring 3 by 3 inches by 7.2 pounds.

The transverse framing above the double bottom is entirely intercostal between the side stringers, the channels being 8 by 3½ by 3½ inches by 21 pounds, and spaced 25 inches apart. The side stringers, three in number on each side, consist in each case of a 15-pound plate 14 inches deep, and flanged 3½

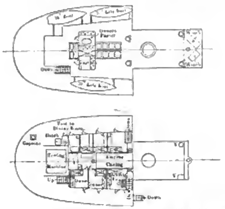


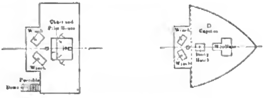
GENERAL ARRANGEMENT OF THE MAIN DECK ON THE GEORGE W. FENWICK, SHOWING THREE HATCHES, AND THE ACCOMMODATION FOR CREW.



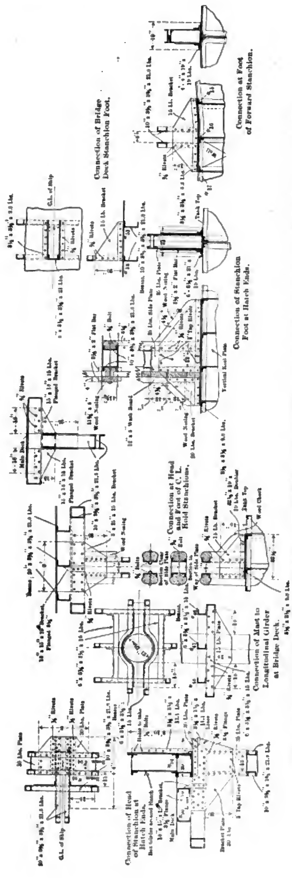
GENERAL ARRANGEMENT OF THE MAIN DECK ON THE NANN SMITH, SHOWING THE TWO LARGE HATCHES AND THREE EQUALLY-SPACED MASTS.

inches to the shell. The inside edge of this plate is fitted with double angles 6 by 3½ inches by 15.3 pounds, which join it to the intercostal frames. At the bottom of each frame is a bracket 36 by 36 inches by 15 pounds, with a 3-inch flange on the inside edge. These brackets are fastened to the inner bottom by angles 4½ by 2½ inches by 12.8 pounds. The brackets joining the frames to the main deck beams are 27 by 27 inches by 15 pounds.





GENERAL ARRANGEMENT OF THE POOP, FORECASTLE AND BRIDGE DECKS ON THE GEORGE W. FENWICK. THE NANN SMITH IS SIMILAR.



DETAILS OF CONNECTIONS ON THE TWO STEAM SCHOONERS, SHOWING THE GENERAL CONSTRUCTION, AND THE LIBERAL USE OF CHANNEL BARS FOR BEAMS AND GIRDERS.

Forward and aft of the collision bulkheads are frames consisting of angles 5 by 3½ inches by 10.4 pounds, with reverse frames 4 by 3 inches by 7.2 pounds. In the engine space the frames are also 5 by 3½ inches by 10.4 pounds, and the reverse frames are 6 by 3½ inches by 13½ pounds. In each case the spacing is 25 inches.

Above the main deck the frames in way of poop and forecastle decks are angles 5 by 3½ inches by 10.4 pounds, increased to 6 by 3½ inches by 13.5 pounds for the bridge deck. In each case a flanged bracket plate, 36 by 30 inches by 15 pounds, connects the frames by means of double angles, 3 by 3 inches by 7.2 pounds, to the main deck.

The main deck beams are channels measuring 10 by 3½ by 3½ inches by 21.8 pounds on every frame, with a spring of 10 inches in the beam of 43 feet. The bridge deck beams are channels fitted on every frame and with a spring of 10 inches. They measure 6 by 3½ by 3½ inches by 15 pounds.

The hold stanchions, or pillars, at the center line consist of vertical double channels, 10 by 3½ by 3½ inches by 21.8 pounds, with side plates at the midheight, 15 by 72 inches by 20 pounds, and wood filling pieces, as shown in the amidship section. These are fastened to the double bottom by means of brackets, 28 by 16 inches by 15 pounds, and angles, 3½ by 3½ inches by 9.8 pounds, with a doubling plate, 28 by 20 inches by 19 pounds, between foot of stanchions and centerplate of double bottom. A continuous horizontal girder just under the center of main deck beams is supported by these stanchions, and consists of double channels of the same size as used for the stanchions. The stanchions for bridge deck consist of channels, 8 by 3½ by 3½ inches by 21 pounds, with double longitudinals at the upper edge, 6 by 3½ by 3½ inches by 15 pounds.

The plating on the main deck measures 14 pounds, decreased to 11½ pounds at the ends, and increased in way of hatches. The stringer plate is 48 inches by 22 pounds, decreased to 31 inches by 17 pounds at the ends. On the poop and forecastle decks the plating is 15 pounds, flanged 3½ inches to the shell. On the bridge deck the plating is 12½ pounds, with 14-pound plate under the windlass. The stringer measures 22 inches by 14 pounds, decreased to 19 inches by 12½ pounds at the ends of poop and forecastle decks.

Bulkheads consist of plates of 13½ pounds, with single frame angles 5 by 5 inches by 14.3 pounds. The vertical stiffeners are angles 5 by 3½ inches by 10.4 pounds spaced 30 inches apart. Horizontal stiffeners of the same size are 4 feet apart.

The stem measures 10 by 3 inches. The stern frame is a separate forging, including a propeller post, 10½ by 6½ inches, and a rudder post 10 by 6 inches. The rudder has been arranged so that the pintle bushings can be renewed without raising the rudder; the latter may be shipped or unshipped while the vessel is afloat. The rudder stock and pintles are, respectively, 8¼ and 4¼ inches in diameter. There is no cementing in the double bottoms except where water is to be carried; but the forepeak, aftpeak and complete double bottom, as well as the forehold, are painted with bitumastic cement.

The hatches of the *Fenwick* are all 20 feet wide in the clear; the two forward ones measure 25 feet each in length, while the other is 33 feet 4 inches. On the *Smith* two hatches only are provided, these being each 25 feet wide and 35 feet 5 inches long. In each case the hatch includes girder coamings, 21 inches by 20 pounds, with angles at top and bottom, and with bracket plate stiffeners where necessary.

Each vessel has three masts, with fore-and-aft schooner rig. Each mast has wood cargo booms, six in all on the *Fenwick* and eight on the *Smith*, each 60 feet long and 12 inches in diameter at the center. The crew are accommodated in the forecastle, while the officers are in the poop; the galley and dining saloon are located also in the poop.

Complete pumping arrangements are provided for rapidly filling and discharging oil from the double bottoms, and ballast water from the holds, while ventilating pipes for the oil compartments are fitted equal in area to the filling pipes. In the wings of the boiler room are the evaporator and ice-plant equipment.

MACHINERY.

Each vessel has one screw operated by a triple-expansion engine, with cylinders 19, 31 and 52 inches in diameter, and a stroke of 40 inches. The low-pressure cylinder has a double-ported slide valve; the others have piston valves. At 90 revolutions per minute, the indicated horsepower is about 1,500. The connecting rod is 90 inches long. The condenser is built in with the frame of the engine. The crankshaft is in three interchangeable sections, 10½ inches in diameter. The crank pins are 10½ inches; thrust shaft, 10¼ inches; and propeller shaft, 11½ inches in diameter. The thrust bearing has water circulation.

The air pump, two bilge pumps and two feed pumps are attached to the back of the condenser, and are operated by a beam from the main engine. Both bilge pumps have connections to the double bottom and the sanitary pipes.

The evaporator, for making up losses of feed-water, has a capacity of 2,000 gallons per hour. The feed-water heater was supplied by the Griscom-Spencer Company, New York. The fuel-oil installation consists of a settling tank, air compressor, and the necessary piping, burners and furnace fronts. The air compressor is of the duplex, double-acting type, with steam and air cylinders 10 and 15 inches, respectively, in diameter, and 15 inches stroke. A duplex, horizontal, ballast pump, 14 by 18 inches, is also fitted.

There are two single-ended Scotch boilers, facing aft, with a total heating surface of 4,944 square feet and a grate surface of 130 square feet, giving a ratio of 38 to 1. Each boiler is 14 feet 6 inches in diameter and 11 feet 6 inches long and contains three furnaces. The steam pressure is 165 pounds per square inch, and the tubes are 3 inches in diameter. A vertical donkey boiler is fitted for the operation of winches.

The propeller is four-bladed, with a diameter and pitch of 13 feet each.

The cargo hoists have steam cylinders 8 by 8 inches, with piston reversing valve. An anchor windlass is fitted forward. Two steam capstans, 6 by 8 inches, one forward and one aft, are fitted with large drums. Steam steering gear (Hyde Windlass Company, Bath, Maine) is placed in the upper engine room, with hand steering gear as a relay. A steam towing machine (Chase Machine Company, Cleveland, Ohio) has cylinders 15 by 18 inches, the towing drum being fitted for 4½-inch cable. A small electric light plant has been furnished by B. F. Sturtevant Company, Hyde Park, Mass.

A Sub-Aqueous Rockcutter Dredger.

When addressing the Royal Society of Arts in January last on the constructive work of the Panama Canal, Mr. Bunau Varilla especially referred to the system of sub-aqueous rock cutting which has been perfected by Lobnitz & Company, Ltd., of Renfrew, near Glasgow. This system originated with a dredger which Messrs. Lobnitz constructed in 1887 for the Suez Canal, in which they introduced on the side of the well a series of hammers, or long needles, actuated by hydraulic rams carried on the framing for the bucket ladder. The object in view was to get rid of the slow and expensive process of boring sub-aqueous rocks for blasting, by means of diamond drills worked from barges on the surface.

After the experience gained with this Suez dredger the plant has been much improved, and as it is likely to be called into requisition for Panama, it is our purpose to describe here a rock cutter which Lobnitz & Company have just completed for operation on the River Blyth, Northumberland. The bed of this river is rock-post sandstone, and is extremely hard. Above the rock was a superincumbent mass of mud and clay, and this had to be removed and the rock bared. Under the old system the next process would have been to drill holes into the rock and then blast it; but a quicker and more economical method is now found in the Lobnitz rock cutter, which has some 500,000 cubic yards of material in Blyth harbor to remove.

The average depth of the harbor is about 16 feet at low water, and the project is to give it a uniform depth of 24 feet at low water and 39 feet at high water. The use of the rock cutter will, it is believed, save £70,000 ($340,000) in comparison with the older method of removing the rock.

There is a great ram, weighing 15 tons, working through a well in the center (or at one end) of a floating barge upon the rock beneath, which it splinters as a nut-cracker crushes a shell. The ram is very long, and has a hardened steel point. It is lifted by a steam winch with a steel rope, and, when at a sufficient height, a clutch is released and the winding drum whirls around very much like the free wheel of a bicycle, and the ram drops upon the rock, splintering it for a considerable radius. The position of the barge is calculated by sighting poles upon the quay, and is regulated by chains, so that, moving about in the river, it covers every inch of the ground. As the cutter proceeds, a dredger (in this case) follows immediately in its wake, and, scooping up the pulverized rock, carries it out to sea and there deposits it.

The rams or hammers in the Suez plant were square, first of forged iron and later of welded iron. They succeeded in breaking even the hardest rock satisfactorily, but the points suffered, and the renewal of the whole bar involved expense and delay. The introduction of the modern process of hardening steel solved this difficulty, and now the cutters, circular in section, are forged from one ingot of hardened steel, and have a removable ogival point, similar in form to that of large projectiles, and made of armor-piercing steel. In some cases in this plant a chisel-shaped point has been preferred for driving into tough rock, and in other cases a point with a series of tooth edges has been used, as in the case of one for the Irrawaddy river, where the current makes it difficult to insure that the blows would be successively struck on the same spot. There has been also important development in the plant to insure great exactitude in the point of contact of successive blows.

The cutter is a round bar of special mild steel, turned smooth in a lathe throughout its whole length. The diameter is thicker at the center of the length than at the two extremities. (The diameter at the center of a 12-ton cutter is about 20 inches.) The lower extremity is fitted with a cutting point fitted in a taper socket, so as to be easily replaced when worn. The top end of the cutter is fitted with a steel thimble, so constructed that the wire-rope is permanently attached to the cutter. The smallest size of cutter used is of 4 tons weight, 20 feet long, suitable for depths not exceeding 17 feet below high-water level. A 15-ton cutter is suitable for 50 feet depth.

The cutter is suspended over a pulley carried on the top of a tripod (or quadripod), the length of cutter and height of tripod being greater than the depth of water, so as to facilitate the guiding of the cutter, which passes through an aperture in a bearing located in the well of the barge, and fitted with springs to accommodate lateral movement or shock. The cutter thus falls vertically upon the same spot, special gear and moorings being fitted on the barge to prevent movement. The barge is maneuvered according to distance posts on the bank, so that each series of blows may fall upon a spot in the rock as marked on a chart.

This rock-cutting machinery may, if more convenient, be mounted on two old barges joined together by logs of wood or steel girders, bolted across on top of their decks; and on

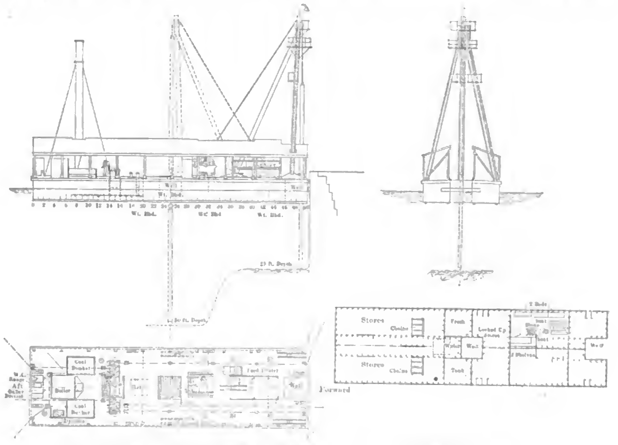
this foundation the rock-cutting machinery is erected. Some rock-cutting machines, however, are in use with one, two or three cutters working together, or a barge may be especially constructed for the machine, as has been done in the case at Blyth, which we illustrate.

With a drop of from 6 feet to 10 feet the cutter breaks its way into the surface of the rock, partly pulverizing it and partly breaking it. The whole force of impact is concentrated on a surface of a few square inches, and this enormous pressure will crush the hardest rock. The cutter is allowed to fall on the same spot until it has penetrated there to the depth desired. After this depth is attained, the barge on which the cutter is mounted is moved a distance of about 2 feet by means of the maneuvering chains, which are worked by a special steam winch designed to insure accuracy of movement. The cutter is then again brought into use until it has sunk into the rock to the desired depth. The barge is then again moved 2 feet, and so on. The cutter falls freely through a hole formed by a guide of steel or of hardwood, so fixed between upright timbers that it can be lifted by a steel wire hoisting rope, to vary the height of the guide according to the depth of water. When the depth of water is greatest the guide is lowered right down to the surface. The wire rope is of special construction, 5 inches in circumference for a 12-ton cutter.

The hoisting winch is a powerful steam engine with gearing and fittings to allow of continuous work. About 1,500 blows per day of ten hours may be given in regular work. It is so arranged with a steel friction clutch and automatic gear that the wire rope follows the fall of the cutter and raises the cutter again at once after the blow has been struck. A feed pump is worked from this winch, which feeds the boiler in proportion to the amount of steam used.

The maneuvering winch is an important part of the machinery. Six maneuvering chains are used. The four side chains are used to traverse the work, delivering blows in a straight line the whole width of the channel and spaced about two feet or more apart according to the nature of the rock. The apparatus is then maneuvered in the opposite direction across the width of the channel. The maneuvering winch is so arranged that the amount of chain taken in on the one side is exactly equal to the amount of chain given out on the other side. The six barrels on the maneuvering winch are all independent. Smaller barrels are also provided, with a quicker speed, for rapidly warping by means of rope when desired.

Base lines are established on shore. On the barge which carries the rock cutter two vertical rods are mounted in slots in a frame. These rods can be moved into other slots spaced 2 feet apart, or whatever distance is desired between the blows. These two rods then form two sighting points, which can be sighted in line with two other rods ashore. The rods ashore are put up square to the base line, and the rods on board the rock-cutter barge are shifted 2 feet every time the barge is advanced, so that the rods on shore do not need to be moved every day. The distance from the base line is measured by means of a graduated wire.



LOBNITZ ROCK BREAKER FOR PULVERIZING SUBMERGED ROCK SO THAT IT CAN BE HANDLED BY A DREDGER.

The builders say that a much larger volume of rock can be broken when the blows are spaced more than two feet apart, but the advantage is entirely lost when the rock comes to be dredged; because when the rock is broken small it is dredged economically, whereas, breaking the rock into larger pieces makes the dredging more costly. One of the features of the rock-cutter system is that the lifting of the broken rock is as easy as ordinary dredging. When explosives are used to excavate rock the pieces are often large and costly to lift; whereas, the rock cutter leaves the debris broken small on an

even surface. A good bucket dredger scrapes the surface of the rock clean before commencing rock cutting, and afterwards removes the broken rock.

Excavation with these cutters is claimed to be more sure, less costly per cubic yard, and more rapid than by any other system known for sub-aqueous rock excavation. A single cutter machine will break up per day in average rock 100 cubic yards for 1 ton of coal and the wages of four men; and the cost of oil, stores and repairs should not exceed the expense for fuel and wages. BENJAMIN TAYLOR.

long, and forecastle 43 feet long. The officers', engineers' and passengers' accommodation is on the bridge, the saloon being tastefully fitted up in polished hardwoods, and the whole of this accommodation is heated by steam radiators. There is a most elaborate arrangement of deck machinery and derricks for the rapid handling of all kinds of cargo, and provision is made for dealing with lifts up to 25 tons weight. A complete electric light installation has been fitted, including clusters of lamps to provide illumination when loading or unloading at night, and a searchlight for use in the Suez Canal.

BOW VIEW OF THE STEAMSHIP HURONA, SHOWING DAMAGE DUE TO COLLISION.

A Record in Shipbuilding.

The 400-foot steamer *Blackwell* has just been built and launched at the North Sands Shipbuilding Yard, Sunderland, in the record time of sixty-nine working days. She was specially constructed to the order of the Tyzack & Bancroft Steamship Company, Ltd., and is designed for trading between Middlesbrough and London and Calcutta. The principal dimensions of the steamer are: Length over all, 417 feet; breadth, extreme, 50 feet 9 inches; depth, molded, 29 feet 9 inches.

The *Blackwell* has been constructed under Lloyd's special survey for their highest class on the spar deck rules and deep frame system, and has a poop 27 feet long, bridge 112 feet

Another Collision.

On Sept. 23 the Allan Line steamer *Mongolian* and the Thomson liner *Hurona* were in collision in the passage of Belle Isle, at the mouth of the St. Lawrence river. Both vessels were badly crushed at the bow, as our illustrations show, it being apparent that the *Hurona* struck the *Mongolian* just aft of the stem, and cut into her a great gash extending below the waterline. One illustration of the *Hurona* shows how the decks of the larger ship crumpled up the bows of the smaller, while the spaces between decks permitted the bows to enter with comparatively little opposition.

The *Mongolian* was in service between Montreal and Glasgow, was steaming eastward, and had on board a cargo of

TEMPORARY REPAIRS IN PROGRESS ON THE HURONA.

5,000 tons, consisting of grain and miscellaneous items, besides about forty passengers. The *Hurona* was en route to Montreal from Middlesbrough, with a full load of general cargo.

The Allan liner was built in 1891 by D. & W. Henderson & Company, of Glasgow. She is a steel screw schooner fitted with seven watertight bulkheads and with a double bottom for water ballast. With a length of 400 feet, she has a beam of 45 feet 2 inches, a depth of 30 feet 6 inches, and net and gross tonnages respectively of 3,088 and 4,838. Her triple expansion engine has cylinders measuring 30, 50 and 80 inches in diameter, with a stroke of 60 inches.

The *Hurona* was built at Barrow in 1892, and is a steel screw shelter deck schooner fitted with six bulkheads and with deep framing. She measures 360 feet in length, with a beam of 44 feet 6 inches and a depth of 23 feet 6 inches. Her net tonnage is 2,150, and 3,432 gross. The triple expansion engine has cylinders of 29, 44 and 71 inches, with a stroke of 54 inches.

Patched up sufficiently to stand the voyage across the Atlantic, and perhaps a good deal more, the *Hurona* has sailed for London. The work of repairing had been done expeditiously and well, and the ship looked fit enough for a lot of rough usage. The broken steel stem was built up of scantling and planks, strengthened by cement. This was then covered over with sheets of iron and painted black. One who did not know might not from her appearance even guess that she had been so badly smashed. She carried a heavy cargo for London, including grain and apples.

The photographs show where the decks of the *Mongolia* intercepted the bow of the *Hurona*, and tore great gashes.

THE HOLE IN THE SIDE OF THE MONGOLIAN.

SIDE VIEW, SHOWING DAMAGE TO BOW OF HURONA.

THE MONGOLIAN PATCHED UP AFTER THE COLLISION.

Reciprocating Versus the Turbine Engine.

In view of the rapid advance made by the turbine engine as the motive power for marine service, it will be interesting to review and note in a general way some of the salient points of the two types of engines, and consider them from a constructive standpoint, and not—as might be inferred from the title—on lines that will involve any of the theories regarding the distinctive features of either type; nor as to their relative economy or adaptability, or for the purpose which they were intended to fulfil; neither as regards the theory or action of the steam and the peculiarity of its flow, nor to take into consideration any of the numerous ideas advanced by those who have made an exhaustive study of the principles involved in the new type of steam motor. All of these features have been dealt with at great length by learned writers on the subject, and their views have been published in the leading technical journals of the day, and need not be considered further here; but more particularly the design, constructive details and the class of workmanship required in the building of the two types of engines, the superiority of which is apparent in the turbine type over that of the reciprocating.

When such comparison is made between the two types, one is amazed at the crudeness, one might say primitiveness, of the workmanship of the latter, as compared with that of the former, the reason for which is not far to seek. If it were not for the high degree of ingenuity and skill in adjustment, and refinement in workmanship required in the building of the turbine engine, it would be as nothing compared with that of the reciprocating type. Aside from special types of reciprocating engines, the marine engine for the merchant service is crude by comparison only. They are efficient and do their work economically to a very high degree. As a matter of fact, the best the turbine class can do is to equal it, but to the best of our present knowledge, never has the turbine engine much excelled the records made by the reciprocating engine. This question need not be considered further here, either, as this is not the part of the subject that we are concerned with at the present time.

The extent to which the refinement of machine work, the fitting and adjustment, is carried out to the minutest detail in the building of the turbine engine would not be considered for a moment by any builder of reciprocating engines; because of the costly methods, and as being uncalled for—not required—or as it might be expressed, "it would not pay." In the case of the turbine it is different. They have to be built that way, for, as said before, the turbine engine would be as nothing if built without such refinement in design and construction, in order to correct the inherent defects in this type of engine. Therefore, we will have to accept the proposition that such refinement is imperative, and is the price to be paid for accepting the turbine principle. Having accepted the inevitable, we then proceed to find ways and means to solve the problem, which has been successfully accomplished, and resulted in placing the turbine engine on a very high plane, showing what can be done by determination and persistent effort when applied in the right direction.

The broad statement is made in the foregoing that the reciprocating engine is a crude affair, as regards workmanship, when compared with that necessary in the construction of the turbine engine. And this fact is readily apparent on close examination of the two types of engines in marine service. Let us consider, in a comparable way, the rotor casing of the turbine, with that of the cylinder of the reciprocating type. The former are made up, in the larger sizes, of from four to six separate sections, and divided in two parts longitudinally, having the heads cast integral with the end sections of the casing, provided with openings through which the rotor shafts work, and fitted with packed bearing heads, not unlike the bottom cylinder head of the reciprocating type.

Of necessity, these casings are too great in dimensions to be made in one casting. At least they must be divided longitudinally to permit the placing of the rotor within the casing. The joints of the several sections must be carefully made and strongly bolted up, to which is added the fitting of the joint dividing the upper and lower part of the completed casing, a joint which must admit of repeated separating and closing, metal to metal, and steam tight under the working pressure. In addition, the casing goes through a process of rough boring and steam seasoning to the final finished boring and grooving, all of which has to be done with the casing bolted together, requiring special boring tools, and the offsets or grooves properly located by accurate measurements made from the outside in the smaller sizes, and from the inside on the larger sizes, all of which is a time consuming process, the like of which is never done on cylinders or any other parts in building reciprocating marine engines.

In the building up of the rotor, another time consuming element is the boring and fitting of the rotor onto the shaft, and the finished turning and grooving, all of which has to accurately conform to that of the casing. The co-efficient of expansion of the metals comprising the casing and rotor has to be considered carefully, and tried out to determine if the two parts will expand in length with the least difference, in order that the rotor blading will not foul that of the standing part in the casing. Then comes the tedious process of blading of both the rotor and casing, the different sizes and length of blading which must be inserted firmly and truly radially, and securely locked in place, all of which has to be done with the greatest care, down to the minutest detail. Then follows the balancing of the rotor, fitting and adjusting it into the casing and bearings, and providing micrometer adjustment longitudinally. Throughout the entire installation the greatest care

must be taken to insure a perfect working condition, to the last fraction of vacuum obtainable.

The separation of the casing for examination of the rotor is a matter of careful design and detail, that it may be lifted with safety and true from off the rotor, without fouling the blading; as it must be, when taking into consideration the great weight of the part to be handled—upwards of a hundred tons in large low-pressure units.

A complete summation of all the numerous details in connection with the building of the marine turbine engine, as we see it to-day, is too great to be considered further here. We have dwelt on the subject only to an extent that will enable a comparison to be made between the two types of engines, as regards their constructive details and refinement in workmanship, as displayed in the building of those of the turbine class, which have been shown to be of a special and costly nature, as is self-evident.

The reciprocating or piston engine of the marine type for the merchant service has its inherent defects in principle, as well as those of the turbine class for the same service, and not the least of these is the limitation of rotative and piston speeds. There are cylinder condensation, wire drawing of steam, large clearance spaces, besides other numerous defects to which the reciprocating class is heir. These, if eliminated in part at least, would place the reciprocating engine on a higher plane than that on which it stands at the present time, —that is, if the cost of such elimination is not considered, as it is evident it is not in the case of the turbine engine.

On just what lines the elimination would best be followed will be a matter of conjecture, and be determined wholly by experiment, as was done in the case of the turbine. If the problem is attacked with determination and a free hand as regards cost, a great deal could be accomplished, beyond question. The building of a 15,000-horsepower unit to try out would be a matter of no small cost, as we know, yet this was done in the case of the turbine. In the balancing problem of the piston engine, much has already been accomplished in the past few years, and the results are highly beneficial as regards higher rotative speeds and reduced vibration. As the crank shaft is one of the factors in the problem, it might be well to consider to what extent refined treatment would apply to this detail. Oil-tempered steel for shafts and pins is a step in that direction, without doubt, to which might be added the grinding of all bearing surfaces and the fitting of shafts in self-oiling journals, and following on the same lines the refined treatment to include all of the numerous details of parts comprising the completed unit.

It would be considered that the steam cylinders are not the least important to which the refined treatment be applied. It could include jacketing on the barrels and heads and their fitting with chilled or hardened steel liners, ground and polished to a high degree. The inside surfaces of the cylinder heads could be machined and highly polished, the same treatment to include the pistons—that is, both sides be machined and polished, then followed by the reduction of the clearance spaces to a minimum between cylinder heads and pistons, and between the cylinder and valve faces. Eliminate the rough cored surfaces of steam passages to the minimum, which could be obtained by placing all valves in the heads, and perhaps of the poppet type. Continuing the same treatment, it would include reheating receivers and an efficient system of drainage down to and including the air pumps and condensers, and the maximum vaccum obtainable, also an efficient system of self-lubrication that would be continuous and never failing. The same treatment would include the problem of compression, as a higher rotative speed and smoother turning effort would be one of the imperative requirements, and would necessarily be controlled from the exhaust side, as a matter of economy.

It will be considered, as a matter of course, that the conjectures as to what parts of the reciprocating marine engine are susceptible to such refined treatment of material and workmanship, as outlined, will be largely of a forecasting nature. But, nevertheless, some of the ideas referred to are actual facts, as we know, and just what beneficial results could be expected from the balance, and others that might be suggested by practical application, is largely problematical.

Without question, it will be accepted that steam cylinders fitted with liners of hard material, bored and ground truly cylindrical and parallel, having the surfaces highly polished, will have a lower coefficient of friction than they otherwise would have, and with the rough surfaces of pistons and cylinder heads machined true and polished, the clearance volume and absorbative capacity would be greatly reduced. The absorbative quality of rough cored and cast, as well as that of roughly machined surfaces of coarse soft cast iron, is known to be much greater than that of hard, close-grained polished metals, and the elimination of such defects would result in the reduction of the cylinder condensation to a large extent.

The greater accuracy of workmanship, as could be applied to the reciprocating engine, would affect and improve its working condition throughout. If accuracy of all bearing surfaces were proved and known, the running clearances could then be determined to a certainty, and adjustments made accordingly. Steam jacketed surfaces and reheating receivers have been used quite extensively in the marine service, but the question of their continued use involves economy of space, weight and efficiency; yet the highest economy of steam consumed per indicated horsepower has been obtained in connection with their use. Therefore, it is reasonable to assume that they are some of the factors in the problem, and should be so treated in this connection.

In dealing with both sides of the question only a small part, covering the details of each type, could be dwelt on, and that only in a comparable way; enough, however, to show the vast difference in the constructive methods of the two types of engines. W. M.

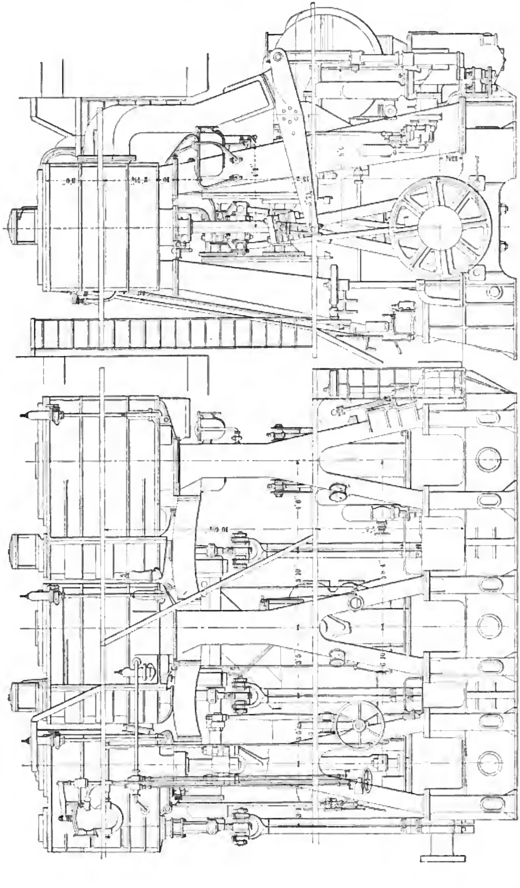
A Japanese Liner.

Messrs. D. & W. Henderson & Company, Limited, Partick, Glasgow, launched last April the steel screw steamer *Chikuzen Maru*, built for the Nippon Yusen Kaisha, of Japan. The dimensions of this vessel are: Length between perpendiculars 310 feet, breadth molded 40 feet, depth molded 26 feet 6 inches, with a gross tonnage of about 2,530. She has been built to class 100 A1 Lloyds spar-deck class, and also in accordance with the Teishinsho rules.

For first class passengers accommodation is provided in staterooms under the fore part of the bridge deck, and there are a dining saloon and smoke room in polished hardwood, of tasteful design. Accommodation for sixteen second class passengers is aft in the poop, with dining room, also in hardwood. Accommodation is provided in forward 'tween decks for third class passengers. Captain, officers and engineers are berthed amidships, and the seamen and firemen forward. Special attention has been paid to the accommodation, all the rooms being large, airy and well ventilated. The vessel is equipped with everything that can add to the comfort of passengers and to economical working of cargo.

The engine is triple expansion, with cylinders 25, 41 and 68 inches in diameter, and a stroke of 48 inches. The working pressure is 185 pounds per square inch. The cylinders are all separate, and the steam connection by pipes, with expansion joints to them. The columns are of the Y type in front, and rectangular at back, and all are tied together at the heads, making a rigid support for the cylinders. The bedplate is of the usual box construction.

The valve gear is of the Stephenson link motion, all



SIDE AND END ELEVATIONS OF THE TRIPLE-EXPANSION ENGINE ON THE JAPANESE STEAMER CHIKUZEN MARU, OF THE NIPPON YUSEN KAISHA.

adjustable, and the eccentric straps are of malleable iron, lined with brass. Steam reversing gear of the "all round" type is fitted, having machine cut gear. Steam turning gear is also fitted.

There are feed pumps driven by the air pump crosshead, also a pair of Weir's automatically controlled pumps, and one Weir feed heater. A suction feed filter (Carruthers make) is fitted between the hotwell and the engine feed pump. The condenser is a separate cylindrical casting, bolted to the two forward back columns. The air pump is driven from the low-pressure crosshead. The circulating pump, of ample size, is of the centrifugal type. Water service is provided through all the thrust shoes, the block being secured to the engine bedplate by forged iron palm ended bolts.

There are two single-ended multitubular boilers, 15 feet 6 inches in diameter by 11 feet 6 inches long, with three fires in each, arranged for forced combustion on the Howden system. The total grate area is 123 square feet, and the heating surface 5,113 square feet, making a ratio of 41.6 to 1. The funnel is provided with a telescopic piece where it joins the smokebox, the main funnel being carried by the beams of the vessel. A large donkey boiler is provided for the winches, which are made by the builders.

A complete auxiliary outfit is provided, consisting of electric light plant, large ballast pump, sanitary pump and general steam pump for deck use, as well as bilges and boilers. The exhaust steam from all auxiliaries is led into a separate condenser, fixed in the engine room, of the "Contraflo" type, made by Richardsons, Westgarth & Company, who also constructed the evaporator and the Geddes water traps for the intermediate and low-pressure valve casings. These traps automatically drain the water from their respective casings, and lead it into the hotwell. Benjamin Taylor.

Vibration in Passenger Ships.*

Some surprise and disappointment has been expressed by passengers on turbine-propelled ships that vibration, although it has been greatly reduced, has not been entirely eliminated from these vessels. In considering this subject, it may be as well to state at once that, no matter what kind of engine be used, vibration never will be eliminated from steamships driven by screw propellers. The hull of a steamship is a highly elastic structure and, therefore, peculiarly sensitive to any forces tending to set up vibration. These forces may be broadly divided into three kinds—the impact of the waves, the unbalanced moving weights of the engines, and certain inequalities in the thrust of the propellers.

Vibrations due to the shock of the waves may be disregarded as being too infrequent to cause any discomfort. It is only in heavy weather that they become of sufficient magnitude to attract the attention of the passengers, and even then it is only at long intervals that the sea will strike a blow sufficiently powerful to cause the whole ship to vibrate.

The second cause, unbalanced or imperfectly balanced moving weights in the reciprocating engine, is, or rather was, the most annoying trouble, since it was responsible for that incessant pounding, and in some cases very violent vertical and lateral vibration, which was for many years the bane of a deep-sea passage. A few years ago, however, after a thorough investigation, Messrs. Schlick, Yarrow and Tweedy devised a system of arranging the relative positions of the cranks and other moving parts of the engine, which resulted in a great improvement; although in the latest high-powered trans-Atlantic ships a considerable amount of engine vibration still remains, especially when the engines are racing. With the introduction of the steam turbine, however, vibration from the engine was absolutely eliminated, the moving parts being perfectly balanced and, therefore, incapable of producing those mechanical couples which, in the reciprocating engine, send a rhythmical series of tremors through the whole structure of the ship.

The public at large, on hearing that an absolutely vibrationless engine had been produced, jumped to the over-hasty conclusion that all vibration of the ship had at last been eliminated. In this they were not altogether to blame; for it must be admitted that the sponsors of the steam turbine, in speaking of its future benefit to marine navigation, had predicted an absence of vibration from the whole ship, which their knowledge of propeller action should have taught them was, in the very nature of things, impossible. The writer has stood in the engine room of the *Lusitania* at a time when there was perceptible vibration in the structure of the ship at a point some 200 feet farther forward, and failed to perceive the slightest sensible vibration of the engines, even when the hand was laid upon the casing of either the high-pressure or low-pressure turbines.

For the causes of such vibration, then, as occurs in a turbine-propelled ship, one must look outside of the hull itself; and it is to be found, as we have already remarked, in the uneven action of the propellers, whose effect does not consist, as it theoretically should, in a constant axial pressure on the ship, but in a thrust which varies from a maximum to a minimum, and is in reality a series of rhythmical impulses. Theoretically, a three-bladed propeller, rotating at a certain rate of speed in undisturbed water, should exert a constant thrust.

But, in the case of steamship propulsion, the propellers, so far from revolving in undisturbed water, exert their thrust upon water that is very much disturbed, and flows past them in streams of varying velocity, full of eddies and more or less complicated motions. This movement is largely due to the friction of the water upon the sides of the ship. The layers of water in immediate contact with the hull tend to cling to it, and are dragged along with increasing velocity, until at the stern of a long ship they are traveling approximately at the same speed as the vessel. This drag on the water decreases with the distance from the hull, until undisturbed water is reached. Now, as a propeller rotates, its blades are alternately reacting upon dead water and water which is moving more or less swiftly forward against the thrust which the blades exert; and, consequently, the reaction against the blades is greater, or of a less yielding character, as they are passing through the water next the hull than when, on the other half of their rotation, they sweep through the still water 15 or 20 feet away from the hull; in other words, each blade once in every revolution hits a hard spot, as it were, in the water, with the result that the impact sets up a series of tremors or vibrations throughout the whole structure of the ship, whose frequency will be equal to the number of blades in the propeller, multiplied by its speed of rotation. Thus, in the case of the *Lusitania*, whose three-bladed propellers make at full speed about three revolutions per second, one would expect to find, if this theory be correct, a frequency of vibration of about nine per second. Observations by recording instruments show that this is exactly what occurs.

It is evident, then, from the above considerations, that although the steam turbine has entirely eliminated engine-room vibration, passengers on future high-speed boats must be prepared to submit to such limited discomfort as arises from vibrations which seem to be for the present entirely beyond human control. Evidently, if vibration is to be entirely eliminated, we must find some other means of propulsion than the propeller. There is one system which would bring about the desired result, namely, that of jet propulsion; but jet propulsion, in spite of the many ingenious efforts to develop it, has never proved a practical success, at least for high-speed vessels.

* *Scientific American.*

HOUSE BOAT SOMMERNACHTSTRAUM (SUMMER NIGHT'S DREAM), WITH ELECTRIC DRIVE.

MODERN MOTOR LAUNCHES.

BY DR. ALFRED GRADENWITZ.

Many of the recent advances in the field of transport and locomotion are due to the extraordinary development of small-sized explosion motors. This applies both to automobilism (which has brought about something like a revolution in modern traffic) and to aeronautics, which seems to be on the eve of a powerful development.

The experience gained in connection with automobile construction has been lately made use of also for the construction of motor launches. As a suitable motor had been developed, no difficulties were experienced in the construction of light and swift motor-driven boats, the more so as such motors will be readily fitted into even the smallest crafts. Motor launches are accordingly at present used to a large extent, both for the transport of passengers and merchandise, for racing, sporting, touring and pleasure purposes, for maintaining regular connections in the short and long-distance traffic, for conveying merchandise from ship to ship, from ship to land, from the place of production to the loading place, and so on. They are even used largely by the authorities as superintending boats in the custom service, mail launches, etc., and even the navy has found it profitable to replace part of their steam pinnaces by motor boats. The low weight, simplicity of operation and readiness for service are the main causes for the rapid strides made by this type of craft, which have brought animation to many waters that had so far been outside of any traffic.

While in most cases explosion motors of the automobile motor type are used for the propulsion of the launches, electric motors fed from storage batteries are fitted not infrequently into the latter, a special advantage of electric operation being the perfect smoothness and absence of any noise, and small electric launches are accordingly especially adapted for use as pleasure and touring boats. When driven by such a motor the boat will traverse quickly the water sheet of mountain lakes, passing by the towering peaks and steep slopes, and disturbing by no creaking or oscillation the grandeur of the scenery.

ELEVEN-METER BOAT WITH 5-HORSEPOWER ELECTRIC DRIVE.

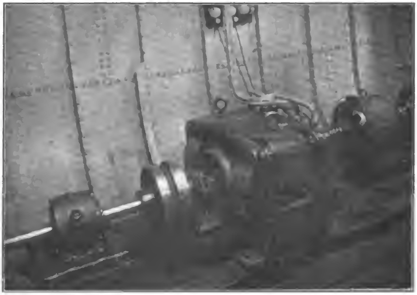
MOTOR FOR DRIVING BRICK BARGE—3 TO 7 HORSEPOWER, 100 TO 125 REVOLUTIONS, 160 VOLTS.

TRIPLE-SCREW, ELECTRICALLY DRIVEN TOWBOAT TELTOW, WITH ACCUMULATOR DRIVE, 60 HORSEPOWER.

The smoothness of operation may be said to be an advantage, even from an economical point of view, the efficiency of the propeller being more advantageous than in the case of explosion motors, so as to reduce the consumption of energy in spite of the additional weight of the accumulator battery, at least in the case of moderate speeds. Electric operation may, accordingly, be preferred wherever no specially high speeds are required, such as in the case of ferries, hauling boats or goods launches.

CONTROLLER FOR ELECTRIC DRIVE.

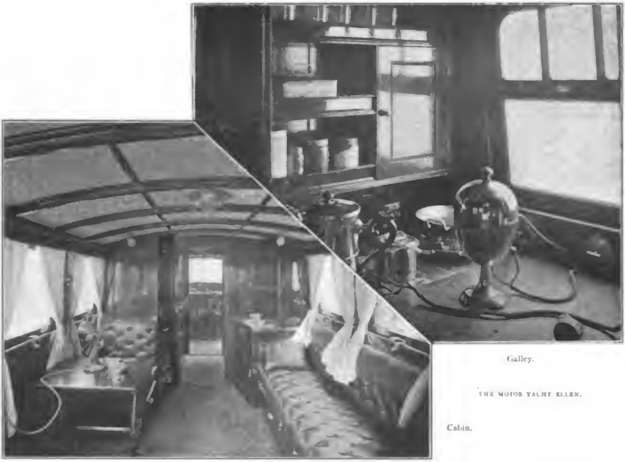
TRIPLE SCREW TOWBOAT TELTOW, SHOWING CONTROL PLATFORM.



MOTOR OF 15-20 HORSEPOWER AT 500 REVOLUTIONS PER MINUTE AND 160-500 VOLTS. TOWBOAT TELTOW.

MOTOR BOAT ELLEN IN MOTION.

The electrical energy stored in an accumulator battery will allow of a single journey up to 100 kilometers (62 miles) in length, after which the battery, having become exhausted, must be recharged. Electric launches are accordingly bound up to charging stations, and are hardly adapted for use as long-distance traveling boats. Explosion motors, operated either by benzine, paraffin (gasoline) or any other kind of fuel, are, on the other hand, very suitable for journeys of several hundreds of kilometers, and while occupying only little space and being of small weight, will be readily replaced whenever required. However, benzine motors are far from being so simple to start and control as electric motors. Endeavors have accordingly been made from time to time to combine the



Galley.

THE MOTOR YACHT ELLEN.

Cabin.

MOTOR YACHT ELLEN, WITH BENZINE-ELECTRIC DRIVE AND ELECTRIC LIGHTING, COOKING AND SIGNALING.

BARGE OF THE BRICK TRANSPORT COMPANY, WITH 7-HORSEPOWER ELECTRIC MOTOR DRIVE.

individual advantages of each of these two systems, and a very practical mixed system has been recently evolved by the Siemens-Schuckert Works, Nonnendamm, Berlin, Germany.

This system comprises a benzine motor and a motor-driven dynamo connected by an electro-magnetic clutch, while another similar clutch connects the dynamo with the propeller shaft. In parallel to the dynamo there is connected an accumulator battery, which on starting will rotate the electric motor as soon as the controller has been actuated, while the propeller shaft at the same time is slowly rotated as soon as the benzine motor has begun working. This is mainly relied upon to yield the energy required to operate the propeller, the electric motor being mainly used to control the speed.

The limits of speed control are very wide ones, as the motor-driven dynamo, in case of reduced speeds, will exert a braking action on the benzine motor, while increasing the total output to about twice the output of the benzine motor in case of increased speeds. The braking energy, however, is by no means lost, but is stored as electrical energy in the accumulator battery. The backward running is effected exclusively by electricity, thus dispensing with any reversing gear. When permanently disconnecting the benzine motor, a purely electric operation can be resorted to, even in forward running, when all the advantages of electric operation will be fully enjoyed. According to the size of the battery and the speed of the launch, this electric service can be extended to one or more hours. The same benzine-motor dynamo set is used, after disconnecting the propeller shaft, to recharge the battery during intervals in operation. The boat thus becomes independent of any charging station, a large advantage over other electrically-operated launches.

Another good point of this mixed system is the possibility of providing, by the aid of the storage battery, for an extensive electric lighting plant, fitting electric fans for ventilating the various rooms, and operating an electric searchlight, as well as a pump for emptying the ship's hold, and an electric siren. Even the kitchen stove in the pantry and the cigar lighter in the saloon are readily adapted to electric operation, and as no matches or open fires need thus be used on such boats, the cleanliness and comfort are obviously enhanced, while the safety against fire is greatly increased.

The illustrations herewith reproduced show some of the various types of motor-driven boats at present in use, including motor boats for the passenger traffic, pleasure and touring boats, launches for use in the towing service on canals and in harbors, and motor-operated boats to be carried on board merchandise vessels. The photograph which represents a brick-transporting barge illustrates the simplicity with which an ordinary barge is adapted to motor operation. The outward appearance of the barge is altered in no respect by fitting the electric motor, while operation is made exceedingly simple, the vessel being able independently of any one of the usual means of transport (towing motors or hauling tugs) to go on its journey far more rapidly than heretofore. Some of the illustrations represent inside views of the mechanical part of a motor-driven launch designed for "mixed" operation.

Use and Abuse of Staybolts.*

The safest and most effective staying for locomotive and marine boilers is a subject of the highest importance. The frequent discussions and conflicting opinions advanced from time to time as to the best methods, etc., are evidence that there is no well settled or uniform plan adopted for this important feature of boiler construction. While it is agreed that metal of high quality and vibratory power is necessary, there seems to be no unity of thought as to the best design of stay-bolt that would come nearest to the qualities of safety, economy and endurance. The strenuous service, the prevailing necessity of rapid heating and cooling of boilers, causing extremes of temperature, the adoption of high pressures and the frequent failures of the constructive parts, often followed by serious results, should attract to the subject our deepest thought and attention.

Stay-bolts have a diversified mission. To the tensile strain, used in sustaining the fire-box sheets in normal position, are added irregular bending forces, due to expansion and contraction. The outer ends of solid stay-bolts are usually at a temperature of less than 300 degrees, while the inner ends are struggling at a temperature of between 700 and 800 degrees F. Torsional strains are also very often in evidence, due to untrue alinement of holes, and thus we obtain, from the first day in service, forces bordering on dangerous fatigue of the metal. However, premature or early breakage is often directly due to impure metal or metal not sufficiently cohesive to long endure the frequent reversal of forces. It is quite evident that to obtain reasonable endurance, iron suitable for stay-bolts must receive special attention in manufacture.

The attention of the writer was called to the use of hollow stay-bolts. The bars from which these bolts are made have a central hole formed by being rolled in the center. This practice assures solidity, increases tensile strength and high elasticity of the metal and prevents any possible defective welds, all being qualities necessary to endurance in stay-bolt service.

The great endurance shown by the hollow stay-bolts is attributed to several causes. The method of rolling, both at the center and outside of the bars, creates a substantial unity of the metal, assures freedom from improper welds, the pure and high quality of the metal, forming the base from which the bars are rolled, tends to both strength and elasticity, the very qualities required to endure continued reversal of strains longer than iron manufactured under ordinary methods.

It is well known that the strength of wrought iron decreases after reaching 350 degrees F. Moderately high fire-box temperatures cause solid stay-bolts to reach the depreciative heat, this being one of the causes which shorten their life. With the hollow stay-bolts in service, a streamlet of cool air passes through each bolt to the furnace, thus holding the metal at a lower temperature, rendering both strength and endurance that cannot be obtained with the use of the highest possible grade of iron in the solid stay-bolt. The greater endurance of the inner ends of the hollow bolts as compared to the solid is

* Abstracted from *The Boiler Maker.*

very noticeable. This is due to the in-rushing oxygen through the hole, cooling the ends of the bolts and reducing the waste of the iron, due to the high heat of the fire.

Hollow stays, with both ends open, will never stop up, as the current of air passing through them always keeps the holes free from sediment. Furthermore, the hollow bolt saves material and time in application and renewals, and also prevents injury to sheets in making renewals, as the operator has a central hole for his drill to follow. John Hickey.

A Novel Dredge Director.

One of the greatest difficulties experienced in operating hydraulic dredges, where a specific cross-section of excavation is desired, is the inability of the dredge operator to know the exact location of the cutter, as regards the outline of the desired excavation, the cutter being concealed from the operator by the non-transparency of the water. Without going into the various methods now employed to keep the cutter within bounds of the desired cross-section of excavation, a description will be of interest of a simple machine which has recently been designed,* by means of which the operator of a hydraulic dredge of the spud and swinging type can so control the movements of the dredge as to produce a cross-section of excavation of any desired shape, which will be entirely within a liberal interpretation of the specifications.

In cases where the question is one of so many feet depth of water between certain lines, as in harbor or channel work; or in the reclaiming of land, where it is a case of filling rather than that of excavating; the exact shape of the cross-section of excavation is not of so much importance. But in canal or inland waterway work, where it is especially desired to excavate to a certain standard of cross-section, the problem of so doing with hydraulic dredges becomes of considerable importance, and past experience has shown it to be a difficult problem to obtain satisfactory results with the present methods of operating such dredges. It is to meet just such a problem that the machine herein described was designed.

The machine consists of a device whereby the exact location of the cutter of a hydraulic dredge, as regards the standard outline of desired excavation, is indicated on a diagram placed in plain sight of the operator or leverman.

It consists of four essential parts:

(*a*) A differential drum located upon the "A" frame of a hydraulic dredge, at a certain determined point.

(*b*) A diagram table upon which is drawn the outline of the desired excavation, and over which runs a tracing point, movable in two directions at right angles to each other, located within plain sight of the leverman or operator.

(*c*) A vertical shaft with a quadrant secured thereto, with a horizontal sighting bar at its upper end, located at the neutral pivoting point of the dredge, on its center line. A circular platform is so located as regards the sighting bar that a man can walk back and forth over same, and, at the same time, by taking hold of a handle at the after end of said bar, rotate the vertical shaft as necessary in the swinging of the dredge on its spuds.

(*d*) Various wires, shafting or other means for properly connecting the above three parts together, so as to make them all work in unison.

The parts are designed so as to be in synchronism with each other, and to so work as to cause the tracing point to move over the diagram in exactly the same manner as the cutter moves over the cross-section of the excavation.

The differential drum *E* on the "A" frame is connected to the ladder (*A*) by means of one wire (*B*), and to the tracing point (*G*) by another wire (*F*). There are two counter weights (*H* and *I*), so arranged as to keep these two wires in constant tension. Thus any raising or lowering of the cutter or its ladder will cause the tracing point to travel across the diagram in a line parallel with the center line of the dredge, and thus afford means for the operator to know at each instant the exact location of his cutter, so far as the depth of excavation is considered.

The quadrant (*L*) aft is connected by means of the two wires (*L'*) to the tracing point, one running on each side of

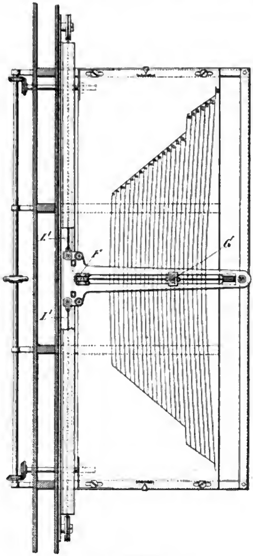


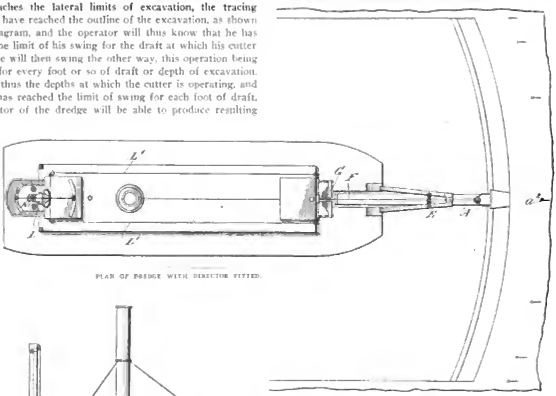
DIAGRAM OF THE OBSERVATION TABLE.

the dredge, like the tiller ropes in a small steamer. Thus any angular rotation of the vertical shaft will cause the tracing point to travel across the diagram at right angles to the center line of the dredge, and thus afford means for the operator to know the exact location of his cutter, as regards the lateral outline of excavation.

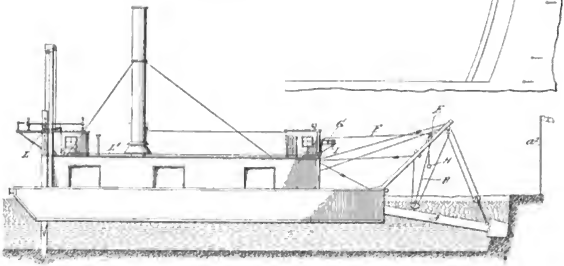
In operating this machine the one essential feature is that the man on the platform at the sighting lever aft shall always keep the sighting bar pointed towards a stake or other mark (a^2) located on the center line of excavation, some distance ahead of the dredge. This being strictly done, as the operator swings the dredge back and forth over the excavation, the quadrant will remain fixed, as far as the center line of excavation is concerned; and, the dredge swinging under it (as it

* United States patent, Feb. 18, 1908.

were), the tracing point will travel across the diagram in exactly the same way as the cutter travels across the actual cross-section of excavation. At the same instant that the cutter reaches the lateral limits of excavation, the tracing point will have reached the outline of the excavation, as shown by the diagram, and the operator will thus know that he has reached the limit of his swing for the draft at which his cutter is set. He will then swing the other way, this operation being repeated for every foot or so of draft or depth of excavation. Knowing thus the depths at which the cutter is operating, and when he has reached the limit of swing for each foot of draft, the operator of the dredge will be able to produce resulting about a center at E and trace waterlines as shown. Various auxiliary devices for securing the greatest possible accuracy of operation are incorporated in the design.



PLAN OF DREDGE WITH DIRECTOR FITTED.



PROFILE OF DREDGE FITTED WITH DIRECTOR FOR LOCATING EXACT CONTOUR OF CUT.

cross-sections of excavation well within a liberal interpretation of the specifications.

Full provisions are made for taking up any slack in the wires, due to changes in temperature or other causes, as well as taking care of any changes of trim in the dredge, or any change in depth of water, due to a rise or fall of the tide, or other causes. By means of an electrical attachment, a bell is caused to ring in the pilot house when the dredge has reached the limits of its swing for each foot of draft at which the cutter is set.

While the above is the simplest form in which it is proposed to install such a machine, it will be possible to have the lateral movement of the tracing point controlled by means of a gyroscope located near the forward part of the dredge, by means of which the inability of seeing the range marks in foggy weather may be overcome.

The curvature of the waterlines on the table takes account of the sensible curvature obtained by swinging the line F from one bank of the excavation to the other without altering the depth of the cutter head. In this case this wire would swing

Shipping of the United Kingdom.

Lloyd's Register reports a total addition to the register of the United Kingdom during 1907 of 918 steam vessels aggregating 1,249,515 gross tons, this being the largest figure, with the exception of 1906, for any year under review. There were removed from the register of the United Kingdom as lost, broken up or sold 425 steam vessels aggregating 531,812 gross tons. This leaves a net addition of 493 vessels of 717,703 tons, this latter figure being the largest for any year except 1902 and 1906. On the last of the year there were 11,400 steamers aggregating 16,501,427 gross tons on the register of the United Kingdom. It will be noted that the average addition was of 1,360 tons, while the average deduction was of 1,251 tons, this indicating a slight increase in the average size of ships on the register.

During the same year there were added to the sailing tonnage of the United Kingdom 287 vessels of 28,599 gross tons, this latter figure being the lowest in ten years with the exception of 1905 and 1906. Deductions from the sail tonnage accounted

for 484 vessels and 128,432 tons, this figure being the lowest in ten years except for 1902, 1903 and 1904. The net balance was a deduction of 197 vessels and of 99,833 tons. The sailing tonnage at the end of the year was represented by 9,660 vessels and 1,575,379 gross tons. This makes the total merchant marine of Britain 21,060 vessels and 18,076,806 gross tons.

During the ten years from 1888 to 1907, inclusive, every year saw a net addition to both the number and the tonnage of steamers; every year saw a net deduction from both the number and the tonnage of sailing vessels; every year saw a net addition to the total tonnage of all vessels; every year, except the first three, showed a net addition to the total number of vessels. It may be remarked that in the ten years under review the net additions of steamers amounted to 2,828 vessels, and 6,077,584 tons; the net deductions of sailing vessels amounted to 2,231 vessels and 1,179,944 tons, while the total net additions amounted to 597 vessels and 4,897,640 tons. This indicates that at the end of 1897 there were included in the merchant marine of the British Isles 8,372 steam vessels and 10,423,843 gross tons, and 11,891 sailing vessels and 2,755,323 gross tons. This makes a total of 20,263 vessels and 13,179,166 tons.

The present figures show a very marked increase, the number of steamers having been augmented by 33.8 percent; of sailing vessels decreased by 18.8 percent, and the total increased by 2.95 percent. The steam tonnage has been increased by 58.3 percent, the sailing tonnage decreased by 42.8 percent, and the total tonnage increased by 37.2 percent. The average size of steam vessels at the end of 1897 was 1,243 tons; in 1907 it was 1,448 tons. The average size of sailing vessels at the end of 1897 was 232 tons; at the end of 1907 it was 163 tons. The average size of all the ships in 1897 was 650 tons; in 1907 it was 859 tons.

Speed in Battleship Construction.*

BY LIEUTENANT A. C. DEWAR, R. N.

For tactical purposes a 3-knot superiority is useful; for strategical purposes, 2 to 3 knots. The question will be examined from a constructional point of view. Speed may be obtained by increasing the horsepower, by decreasing the resistance (as in improved lines), or by increasing the percentage of effective horsepower (*e. g.*, by improved propeller design).

The horsepower required varies approximately as the cube of the speed. At a certain point the curve of horsepower and speed begins to steepen abnormally, and it is uneconomical to supply horsepower beyond this point. The critical speed for a battleship of the *King Edward VII.* type, beyond which the resistance begins to increase rapidly, is about 17½ knots. Thus the last knot in the *New Zealand* absorbs 20 percent of the total horsepower, and as machinery weight and space vary more or less directly as the horsepower, an increase of 20 percent horsepower means a one-fifth increase in boiler-room length, with increased weight of hull and armored belt. Beyond the point at which the horsepower curve begins to steepen rapidly, the increments of power required for additional speed are so great as to practically break up a vessel's design. Thus in the *Lord Nelson* the curve steepens at 18 knots, and an additional knot would require a total of 24,500 horsepower, or an increase of 45 percent, while the space required would be impracticable on present dimensions; for 20 knots the horsepower required would be 37,000, or an increase of over 100 percent.

If a ship is built with good lines, it requires less horsepower to obtain its speed, and to attain this, model vessels exactly shaped to a variety of lines by an ingenious tool are run in an experimental tank; the power required is very delicately measured, and the lines which offer least resistance selected. There is also a certain favorable draft to obtain the utmost speed. For a 16,000-ton ship the most favorable draft is 27.1 feet for 19 knots, and 26.5 feet for 18 knots. An increase in speed can also be sometimes obtained by utilizing non-effective horsepower; at present only about 45 percent of indicated horsepower is actually effective, 15 to 25 percent being lost between the propeller and the water. A change in the propeller blades of the *Drake* and *County* classes resulted in an increase of ¾ knot in speed.

Increased indicated horsepower can also be obtained by higher pressure or increase of revolutions; thus, in the *Triumph* and *Swiftsure*, a large saving of weight and higher speed is obtained by designing the engines for an increased rate of revolutions. The revolutions are 157 against the *Duncan's* 124, giving 14.1 horsepower per ton of machinery against the *Duncan's* 11, and 20 knots against the Duncan's 19, at the expense of greater wear and tear, and possibly a greater likelihood to breakdown.

Improved boilers also give higher pressure and horsepower for less weight. Thus the *Hyacinth*, a cruiser of the same type as the *Juno* (which had cylindrical boilers), gained 2 knots in speed and saved sufficient weight to replace the *Juno's* 4.7-inch guns by 6-inch by the use of watertube boilers. In the *King Edward VII.*, on the contrary, the adoption of a combined boiler system (fourteen Babcock & Wilcox and six cylindrical) involved an increase of 150 tons in weight, and the lower pressure required larger cylinders and more space.

The weight required to obtain the last knot in various designs varies in different vessels. The *Drake's* last knot cost 500 tons in weight, corresponding to about 2,000 in displacement. The *Renan* obtained 1 knot extra with an increase of 1,100 tons and the removal of four 16.4cm. (6.4-inch) guns. In the *Idaho* class 1 knot extra for a 17-knot battleship involved an increase of machinery weight of 570 tons, which, with increased length of hull and armored belt, would mean an increased displacement of about 2,500 tons. The *Good Hope* required 700 tons to get her last knot; and in the *République* an increase of 1 knot would mean an increase in displacement of 1,000 tons.

An analysis of the extra displacement required to increase the speed from 18 to 19 knots in the *Charles Martel* (11,700 tons, 14,500 horsepower) is as follows:

	Tons.
Increase in machinery weight	230
Increase in hull weight	310
Increase in armor weight	380
Increase in coal weight	80
	1,000

—an increase of 230 tons in machinery, necessitating an increase of 1,000 tons, or 4.4 times its own weight, in displacement.

Up to the introduction of turbines in the *Dreadnought*, the speed of battleships has varied between 17½ and 19 knots. The normal, or what may be termed the representative, speed with reciprocating engines has oscillated ½ knot on each side of 18. The *King Edward VII.* obtained ½ knot lower speed and four additional 9.2-inch guns with an increased displacement of 2,350 tons. The *Lord Nelson* obtained ten 9.2-inch instead of twelve 6-inch guns, and an additional 1 inch on her belt, by a decrease of ½ knot and an increased displacement of 2,500 tons. The trend, then, has been towards an increase of armament rather than an increase of speed. The *Duncan's* 19 knots was obtained only at a very considerable sacrifice of protection. Similarly in German and French types, speed has

* The United Service Magazine.

remained practically stationary at 18 knots, and armament has gradually increased. In American ships speed has varied from 17 to 19 knots, while very heavy armaments have been mounted. Thus the *Connecticut*, with 18 knots, carries four 12-inch, eight 8-inch, and twelve 7-inch, against the *King Edward VII.* (18½ knots) four 12-inch, four 9.2 and ten 6-inch, by saving in—

	Tons.
Machinery	600
Armor	285
Coal	80
Hull	200

The *Connecticut*, with less speed and less machinery, can afford to be shorter by 25 feet, and so saves considerably in hull weight and armor. Speed, then, in the last decade has remained practically stationary, and the reason has already been given—with reciprocating engines and average displacement, any increase beyond the representative speed of 18 knots called for excessive sacrifices. To give the *Lord Nelson* a speed of 21 knots would have necessitated an increase of about 1,100 tons in machinery, which would mean a displacement of nearly 20,000 tons, or an increase of 3,000 tons.

The introduction of the turbine, however, broke down these limitations. A speed increase of 3 knots, better armament, protection, and radius of action were possible with an increase in displacement of 1,500 tons and an additional cost of £300,000 ($1,460,000). It is important then to distinguish the position of the turbine in the present controversy over speed. The original line of increased armament has been followed, combined with an increase of speed rendered possible by the use of turbines.

The introduction of the turbine has caused a sudden rise in speed compared with the older type of battleship; but, when its use becomes general, speed will probably again reach an economical limit, oscillating a knot or so on either side, and strategical and tactical requirements will again have to subordinate themselves to constructional limitations. To increase displacement by 3,000 tons and cost by about £300,000 simply to obtain 3 knots more speed would be inadvisable, but it is a sound policy to increase the displacement by 1,500 tons, if by so doing a decided improvement is gained, not only in speed but in protection, radius of action and armament.

Criticisms on the *Dreadnought* armament* must not be confused with the speed question. The only factor to be considered relative to speed is the percentage of the total displacement allotted to armament; the nature of the armament does not affect the question. In the *Braunschweig*, armament amounts to 11.3 percent of the displacement; in the *République*, 11.3; in the *Formidable*, 10.9; in the *Lord Nelson*, 19; in the *King Edward VII.*, 14.5; and in the *Dreadnought*, about 14.8 percent. It is clear, then, that armament has not been sacrificed to speed. Greater armament and greater displacement has been the trend of battleship evolution, and the *Dreadnought* does not depart from this principle, but in her case the representative speed has been increased to 21 knots by the use of turbines.

Turbines and oil fuel also mean a smaller engine-room staff and an easier maintenance of speed, though the expense of the latter is a drawback, being 0.45d. (0.91 cent) per indicated horsepower against 0.18d. (0.36 cent) for coal. Oil, too, has a very important bearing on radius of action, for not only is its calorific value greater than coal for equal quantities, but a greater quantity can be stowed in the same space. If 2,000 tons of coal will drive a ship 2,000 miles (approximately), 2,000 tons of oil, having greater fuel energy in the proportion of five to four, would suffice for 2,500 miles; but the stowage space required for 2,000 tons of coal would stow 2,300 tons of oil, which would suffice for 2,840 miles, or a radius of action increased 42 percent by the use of oil.

Oil fuel can also be supplied much more easily and regularly to the boilers, and so speed can be better and more economically maintained. In the race of the first cruiser squadron from New York to Gibraltar, the speed dropped from 21 knots to 18 knots immediately the reserve bunkers began to be used, which might have an important strategical bearing, and which is avoided by the use of oil. Fueling at sea, too, would be much easier and safer, as no glaring lights would be necessary, and the ship could be ready for action in a quarter of an hour. This is impossible when coaling with Temperley's, and the old-fashioned coaling will always remain a risky operation within 150 miles of an energetic enemy's coast. The smoke difficulty with oil is now almost entirely overcome; the Dürr system with Texas oil produces less smoke than Welsh coal.

Watertube boilers have also a strategical value, as steam can be raised very rapidly. A ship steaming at 10 knots with four boilers alight could increase to full speed with twenty boilers in 1½ hours. To achieve the same result with cylindrical boilers, all boilers would have to be kept banked, which would mean an extra coal consumption of 60 to 80 tons per diem in a battleship. These advantages are less heard of, but are none the less very material, and they are combined in our later types of ships. With regard to cost, the figures per ton for a modern ship are approximately—

	First Cost	Upkeep Per Annum.	Annual Repair.	Triennial Refit.
Cost per ton......	£95	£5.4	£1	£4
	$462	$26.25	$5.00	$19.50

One knot in speed may be taken as representing 1,000 tons displacement, and therefore involves an additional first cost of about £95,000 ($462,000) and an annual charge of £7,700 ($37,500). Three knots of speed, then, would mean an increased first cost of about £285,000 ($1,385,000) with an annual charge of £23,000 ($112,000). If the faster ship costs 1.8 millions ($8,750,000), the slower would cost 1.5 millions ($7,300,000), and six slow ships would correspond financially to five fast. Assuming that the armament of slow and fast is equal, the fleet fire volume of six slow would be 20 percent greater than of five fast, but this would perhaps just compensate for the inferior speed. Financially and tactically the two fleets would be on a par, but in forcing or evading action, the faster fleet would, of course, have a great advantage, not the least being the ability of its units to go to and fro unescorted.

As a matter of fact, in the *Dreadnought*, 3 knots greater speed is combined with a slightly heavier armament. If the rate of fire per minute at *long range* be taken as two for a 12-inch and three for a 9.2-inch, the *Lord Nelson* throws a broadside of 12,400 pounds per minute, against the *Dreadnought* 13,600; six *Lord Nelsons* would cost the same as five *Dreadnoughts* and would have a fire volume superiority of only 8.5 percent, which would not counterbalance three knots speed inferiority. Financially, then, a fleet of *Dreadnoughts* compares favorably with one of *Lord Nelsons*, and though the financial risk from submarines and mines is greater, the larger ship is also less easily disabled.

Any comparison of features complementary to one another is so dependent on circumstances, that no dogmatic conclusion can be arrived at. The relative value of the heart and lungs, of man and woman, of intelligence and physique, cannot be defined in figures. One factor, however, is usually dominant, and the great majority of captains, if asked to choose between 2 knots in speed and two 12-inch guns, would choose the guns. Armament is the first consideration in a battleship, and if it is essential to bring the enemy's fleet to action, for every eight

* Some artillerists prefer the *Lord Nelson's* armament—a combination of 12-inch and 9.2-inch; the retention of the 6-inch is advocated by others.

battleships built, a fleet of three battle cruisers should be provided. A difficulty in the way of providing heavier armament is the enormous length of our guns, which really require as great a hull length (and therefore additional hull and armor weight) as speed. The matter might be greatly simplified by using a shorter and stronger gun with heavier charge, but that again would require heavier and stronger mountings.

In any case, arguments against large battleships cannot be based on historical records. Railway managers do not base their traffic sheets on coaching records, and there is as much difference between a modern battleship and a sailing vessel as between a locomotive and a stage coach. Yet a competent naval writer has actually based an argument against the *Dreadnought* on the number of seventy, eighty and one-hundred-gun ships in the post-Napoleonic period. This is a good instance of a fallacious study of history. The large sailing ship was unpopular because it was slow, clumsy, and sagged to leeward; the large modern ship is faster than the small and just as handy; the large sailing ship was superior only in number, not in size of guns, which had no greater range than those of a seventy-four. The large modern ship carries heavier metal with greater range, and its size is a consequence as much of its speed and protection (a factor entirely absent from wooden construction) as of its gunpower.

The real arguments against large ships are the necessity of large docks, greater cost, and increased loss in event of accident, but these arguments have not prevented a gradual increase in the size of all battleships.

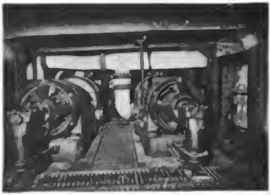
The whole problem can be summed up in a few words—armament is essential and speed is necessary, and the only solution is increased displacement. The question is continually asked, "What limit is there to the size of these mammoths?" The same question may be asked of Atlantic liners (which are nearly twice the size of our largest battleships) or sky-scraping hotels—no precise limit can be laid down. It depends on the progress of mechanical science and international competition, on the one hand, and financial policy on the other. The *Dreadnought* type gives distinct advantages, which, of course, have to be paid for.

Electrical Equipment of the Steamship Momus.

It is a well-known fact that on board ship, where every inch of space counts, all generating apparatus, whatever its nature, must above all possess the feature of compactness. To no other part of the generating apparatus does this apply with more force than to the generating sets for electric light and power. The space usually reserved for the electrical apparatus is always comparatively small, and at times totally inadequate for the proper handling of the apparatus. It is, therefore, not surprising that marine engineers are always eager to adopt any type of generating set that embodies compactness, with the ability to give reliable and satisfactory operation with minimum attention. A noteworthy example of a modern marine generating plant is found on board the steamship *Momus*, built for the Southern Pacific Company, of New York, by William Cramp & Sons, of Philadelphia.

The generating units consist of two 75-kilowatt, 110-volt direct-current generators, direct connected by means of flexible couplings to Curtis steam turbines of the horizontal type, revolving at a speed of 2,400 revolutions per minute. Each turbine is of the two-stage condensing type, each stage having two bucket wheels and one set of intermediate or fixed buckets. The turbines and generators are each equipped with two bearings, and each set is assembled on a rigid bed-plate cast in one piece.

The generators are of the four-pole compound-wound type, and of the latest and most improved General Electric design.



TWO CURTIS-GENERAL ELECTRIC TURBO-GENERATORS.

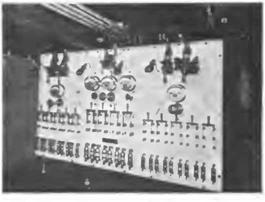
On account of the high speed, the commutators are of the shrink ring construction, the segments being held firmly in place by steel rings shrunk on the commutator and insulated therefrom by mica bands of suitable thickness. Specially treated carbon brushes eliminate commutator troubles and reduce brush friction to a minimum.

With 250 pounds steam pressure, 28 inches of vacuum and 100 degrees F. superheat, the steam consumption per hour at full load is 24.5 pounds per kilowatt, delivered at the generator terminals, assuming the generator efficiency at 90 percent. This figure is equivalent to about 16.5 pounds per brake-horsepower under the conditions given.

The high speed of operation makes the question of lubrication a very interesting one. All working parts of the valve gear, including the oil reservoir on the hollow governor lever, are oiled by hand. The main bearings are furnished with oil under pressure from an oil pump on the end of the generator shaft. All four pillow blocks are provided with auxiliary oil wells and rings. The bearings are of the self-alining, ball-seated, babbitt-lined type, made in halves. Notwithstanding the high speed, no vibration is noticeable when these sets are running under full load.

A 10-kilowatt generating set, consisting of a General Electric marine-type 110-volt generator, direct connected to a single cylinder engine of the same make, furnishes power for the ordinary day load of the vessel when at sea, and is also used when the vessel is discharging cargo at the docks.

The switchboard is constructed of white marble, and consists of three panels; the outside panels being for the 75-kilowatt sets, while the inside panel is for the 10-kilowatt set. The switchboard is equipped with the necessary instruments, and the connections are so arranged that the 75-kilowatt sets



THE MAIN DISTRIBUTING SWITCHBOARD.

may be run in parallel, and any circuit may be connected to any set.

This vessel is equipped with a 24-inch General Electric searchlight, with pilothouse control. The light is installed on top of the pilothouse, and projects a beam of light of sufficient intensity to render plainly discernible, on a clear, dark

THE SEARCHLIGHT.

night, a light colored object 10 by 20 feet in size, at a distance of not less than 5,000 yards. This lamp is of the horizontal carbon type, and is designed for both hand and automatic feed.

Besides furnishing power for light, the generating sets supply current for the electric heating system, ventilating fans and numerous small motors driving dish-washing machines, ice cream freezers, etc. The electric heaters, of which there are 175, were designed especially for this installation by the General Electric Company. The use of electric heaters was a rather bold and unprecedented departure from the regular practice of steam heating, but up to the present time the operation has been entirely satisfactory.

A New Method for the Purification of Water.*

With the advancing development of the industrial arts, competition also becomes continually sharper, so that the manufacturer is compelled—as much as circumstances permit—to take advantage of the tireless progress of the technical arts. It is not long since one contented himself, fatalistically, with ignoring all the disadvantages which bad feed-water caused in the operation of the steam boiler, or hard and muddy water brought about in manufacturing operations.

Twenty-five years ago there were few manufactories which softened and cleared the feed-water for the steam boiler. When this was done, it was effected principally through large receptacles, which were filled with the water to be treated, and into which were introduced soda and lime-milk or caustic soda, or soda alone, together with a considerable pre-warming. The mixture was stirred, and, for the sake of the chemical reaction and clearing, left standing for a considerable time, and then the softened and cleared water drawn off. Other so-called anti-scale means, operating chemically or mechanically, and which were directly introduced into the boilers, have already had their true values proved and their analysis published.

Up to the present time, carbonate of soda, caustic lime and caustic soda have shown themselves the best suited, and the cheapest means for the transformation of the dissolved scale-forming lime and magnesium salts; and these have come almost exclusively into use. Since the introduction of continuously and automatically operating apparatus, the practice has passed from the primitive purification in large receptacles, which requires great attention and a great deal of room besides being expensive, so that now only the former method is in use. The knowledge among possessors of boilers that a rational method for the purification of water is of very great advantage has induced many firms to build water purifiers.

Now, although pretty much every one of these firms has been more or less successful in providing its especial equipment with new and, for the most part, patented devices, which, in comparison with the apparatus of other works, are said to have brought about a better mixing and a more economical consumption of the chemicals, or a rapid removal of the precipitated sludge, nevertheless it can not be maintained that one or another of the systems has succeeded, on the basis of these novelties, in driving the remainder off the market, or in making itself the only ruling system. The reason for this is that, on the one hand, with every apparatus, even of the older process, a sufficiently good and cheap purification may be secured, in so far as that apparatus conforms merely to the general conditions of construction relating to the art of water purification; while, on the other hand, certain evil effects, called forth by the purification and growing out of the chemical occurrences, are not removed even through the later devices.

With the process, hitherto customary, in the use of calcined and caustic soda separately, or in combination with each other or with caustic lime, the salts remaining pass into the boilers. In order that these may not reach too strong a degree of concentration, the boiler water must be, now and again, drawn off and replaced by fresh water. The exudations of sulphate of soda at the fittings and rivet holes are an unpleasant incident, which, up to the present, has had to be reckoned with. A real advance in the province of the art of water purification is, therefore, scarcely to be expected, so long as one limits himself to altering the apparatus in form of construction, or even to improving it, but retains in other respects the former procedure.

Among those who are concerned with this department, a new process of water purification by means of carbonate of baryta, by virtue of which the above-mentioned evils are avoided, has, therefore, awakened considerable attention. This rests upon the fact that the finely pulverized carbonate of baryta transposes itself very energetically with the sulphate of lime contained in the water, and in such manner that sulphate of baryta and carbonate of lime are formed, both of which are insoluble in water and, on that account, are precipitated as sludge. Thus the very important phenomenon comes to light—that not only the sulphate of lime, which was dissolved in the water before its purification, and which appears in the boiler as a scale former, is precipitated, but also the chemicals occasioning its precipitation. For this purpose it is requisite that a corresponding and sufficiently large mass of carbonate of baryta be present, through which the water to be purified is passed. To accomplish this it is added in pulverized form, and in considerable excess—in most cases sufficient for several months—and thus without mixing.

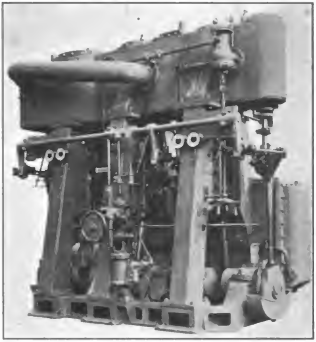
This is carried on in the receptacle for reactions and clarification belonging to the apparatus constructed for this process. In the lower conical part of this the water to be purified enters by fits and starts. By this means is brought about a continually renewed whirling up of the baryta, and the sulphuric acid contained in the water is completely bound by it. In the upper part of the purifier the water passes through a filter, in which all the sludge particles which may have been carried along are retained. These are, from time to time, washed back into the bath of baryta—for one thing to avoid the loss of baryta and for another to cleanse the filter. In order to free the water from carbonates, caustic soda is employed, which is dissolved

* Translated from *Maschinen und Metallindustrie-Zeitung.*

in a continuously-operating Dervaux lime saturator, and led to the reaction receptacle.

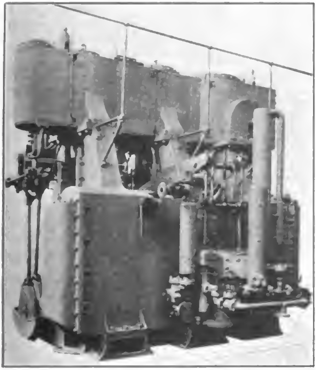
In connection with the devices already carried out, and which have been in operation for two years, for this kind of water, it has become manifest that a renewal of the carbonate of baryta, according to the hardness of the water, is necessary only every one to four weeks. The drawing off of the sludge, on the contrary, need be carried out at most only every three months. The current expense is frequently less—but usually not higher, or but slightly higher—than with the soda-lime process. But if one takes into consideration the advantages of the new process, then this slight increase in cost vanishes. For since, with the tranformation of the sulphates, none remains in solution, even the troublesome exudation of sulphate of soda ceases, which (if allowed to continue) causes not merely the ruin of the fittings but also other evils—as, for instance, increase of the specific gravity of the boiler water, and increase of the boiling point, resulting in a reduction of a saving of fuel. Extremely hard water cannot be softened through treatment by means of carbonate of soda, apart from excess of the same, and very considerable prewarming, to the extent that it passes on without an after-reaction in the boiler as well as on the way to it. And so deposits are made in the piping, prewarmer and injector. These cannot arise with the purification by means of baryta any more than can foaming of the boiler water, which, especially in locomotives, is so important on account of the so-called "spitting."

In the case of the presence of corroding substances in the water—for instance, chloride of magnesium, which is not present in all waters and, for the most part, only in exceedingly small quantities, and upon which baryta exercises no influence—a breaking up of the chloride of magnesium into magnesium hydrate and common salt is brought about by the addition of suitable chemicals. It is thereby made completely harmless, so that no corrosion can arise. It may be added that carbonate of baryta cannot be applied in the place of the carbonate of soda without further ado, but that there is needed for this purpose an especial arrangement in the apparatus for the purification of the water. But water purifiers of almost every sort can easily be modified for this purpose. The new process is patented.



STARTING SIDE OF ONE OF THE TRIPLE-EXPANSION ENGINES OF CUBATAO.

THE TWIN-SCREW STEAMER CUBATAO ON TRIAL TRIP.



BACK SIDE OF TRIPLE-EXPANSION ENGINE OF CUBATAO.

The Steamship Cubatao.

On Oct. 21, 1907, Craig, Taylor & Co., Ltd., launched from their yard, at Thornaby-on-Tees, a handsomely modeled twin-screw steamer of the following dimensions: Length, 286 feet; beam, 44 feet 9 inches; depth, 17 feet 6 inches. She is designed to suit the special trade of the *Lloyd Brazileiro,* and is of the single deck type, with deckhouses amidships and forecastle forward. She was built under special survey to class with the British Corporation. The vessel has double bottom for water ballast in the holds, and has also water ballast in the peaks.

The machinery was constructed by Blair & Co., Ltd., Stockton-on-Tees, and consists of two triple expansion engines, with cylinders 14, 22 and 37 inches in diameter and a piston stroke of 24 inches. These are supplied with steam by two large steel boilers working at 185 pounds pressure per square inch. The vessel has Vicker's stern tube appliances.

She is fitted with vertical steam windlass with quick warping ends by Clarke, Chapman & Co.; Hastie's Wilson-Pirrie steam steering gear, placed in house aft, and worked from bridge amidships by telemotor; eight steam winches; double derricks for rapid loading and discharging, with gins and blocks having Reid's patent sheaves; Clayton fire and disinfecting machinery; electric light by Siemens Brothers, and all modern improvements for a first class cargo steamer for the Brazilian trade, including Waile's-Dove's bitumastic enamel to the tanks, Christie's sparring cleats, litosilo to cabins, Hoskin's beds, and lifeboats with Mills' disengaging gear.

A New Transfer Towboat.

Transfer No. 21, built to the order of the New England Steamship Company by the Fore River Shipbuilding Company, of Quincy, Mass., is a single screw towboat of the following dimensions:

Length between perpendiculars.........	111 feet 10½ inches
Breadth molded	26 feet
Depth molded.........................	14 feet 6 inches

In design and general appearance she is similar to existing towboats of the owners' fleet, having a towboat stern and round-up stem, with one smokestack and one signal mast. A steel deck house has been built on the main deck, and extends for about three-fourths of the vessel's length amidships, which in addition to inclosing the engine and boiler hatches, has accommodations and mess room for the crew in the afterpart and the powerful wrecking pumps in the forepart. On top of this house is a wood erection inclosing pilot house and directors' room.

The vessel has been fitted with powerful oak towing bitts and nigger heads capped with brass, and is fended all fore and aft with stout oak guards faced with steel, in addition to the usual portable hickory fenders. Provision is made for the transport of fresh water in two deep tanks in the fore and after peaks.

The propelling machinery consists of one inverted compound surface condensing direct-acting engine, with a high-pressure cylinder, 20 inches diameter, and a low-pressure cylinder of

TRANSFER TUG NUMBER 21, OF THE NEW YORK, NEW HAVEN AND HARTFORD RAILROAD.

44 inches diameter, having a common stroke of 28 inches, and designed for a working pressure of 160 pounds per square inch. Steam is supplied by one multitubular return tube Scotch boiler, 15 feet 3 inches mean diameter by 12 feet 6 inches long, fitted with three corrugated furnaces 4 feet 2 inches inside diameter.

A duplex fire and wrecking pump, 15 by 12 by 12 inches, fitted with fire plugs and wrecking suctions, the former arranged for fire gun nozzle on top of pilot house, has been installed, with all connections complete, arranged to pump from tanks, engine and boiler compartments, as well as from the sea. The usual outfit of auxiliary machinery has been supplied and fitted complete.

The vessel, during the trip from the builder's yard to New York, developed a speed of over 12 knots without forcing.

MARINE ENGINE LUBRICATION.

Under this heading three of the prominent lubricating concerns in the United States have furnished us with information regarding their own particular types, none of which is the usual fluid oil. These statements have been set down side by side, each being recognized to be partisan with regard to its own particular specialty. Along with these we are republishing an article which appeared in our columns more than four years ago, and which was written by one of the engineering officers of the United States navy. This was the result of observations during a protracted experience at sea, and, so far as we know, was totally without bias.

NON-FLUID OIL.

With the standardization of types and the adoption of well-tried dimensions and proportions for steam prime movers, breakdowns and derangements of engines are coming to be more and more referable to the one feature of design which has not kept pace with the imprnvements—engine lubrication. In a recent paper, the experts of the American Blower Company, Detroit, are quoted to the effect that 80 percent of the small engine troubles are due to improper lubrication; whereas, only 10 percent are due to inadequate proportions of the working parts, and the other 10 percent to the neglect or ignorance of the operator.

Particularly is this true in marine engineering, where special conditions render proper lubrication difficult under the most favorable circumstances, and the great multiplication of small engines, such as independent air, circulating, bilge, and feed pumps, ash hoists, fireroom blowers, ventilators, refrigerators, anchor and winch engines, dynamo engines and various special devices, give reliable automatic oil supply an importance out of all proportion to that obtaining in shore practice.

Though numerous enlightened systems of comprehensive design have been introduced and adopted in various forms by large shipbuilders, the greatest diversity exists on different ships, in the lubricating arrangements as well as in the choice of unguents. It may safely be said that the old style of individual oil cup, with wick tubes and wick, is still the prevalent device. Cylinders of vertical engines, as well as slide valves of the piston type, are often not oiled at all, particularly since the publication of Prof. Lewes's epoch-making paper opened the eyes of the marine engineering world to the dangers of admitting oil to the boilers through condensed feed water. Time was when no main engine was turned over without liberal injection of two or three oil pump reservoirs full of cylinder oil into the cylinders and valve chests, and each cylinder was fitted with its steam cut-off oil cups, besides the steam-operated sight feed on the high-pressure valve chest, and frequent doses through the indicator cocks whenever "she grunted," or the engineer felt that "she needed it." If no oil is used from the outset, if a slight injection is given and the cylinders are carefully drained just before "securing" the engine on coming into port, and the covers are frequently taken off to allow the cylinder walls to be swabbed out and oiled, the internal lubrication may be trusted to the effect of steam, and the use of oil be reduced to a surprisingly low amount. Nevertheless, oil cannot be wholly eliminated from the feed water, as the flat slide valves customary on the second intermediate and low-pressure cylinders do require oil, besides which a good deal is carried through the stuffing-boxes by the "swabbed" piston rods. Of grease extractors, we have tried many types, but found most of them inefficient, owing, mainly, to the positive disinclination of the oilers to renew and clean the filter pads, lufa, straw or whatever material may be used.

For crank pins the centrifugal oiler has proved very reliable. Wipers are to be execrated as wholly unsatisfactory. A great incidental advantage of the centrifugal oiler is that it permits the engineer to admit water to the pin and to locate a thump. Special devices of swinging pipes to the crosshead and crank pins, such as the Hills-McCanna, have been used to good effect. Crosshead pins are frequently supplied by telescopic oil pipes, by wipers placed at the top of the stroke and by direct drop from wick-supplied tubes led in under the cylinder and delivering to boxes carried by the crosshead. Of all these systems the swinging tubes are most positive in action.

Despite all these actions, a great deal of the oil is thrown onto, or rather at, the crosshead and crank pins on the "hit or miss" principle, by oilers and engineers with their squirt cans. This is particularly true of the vibrating link, the valve stem and rock shaft journals, and to a lesser degree of the numerous bearings and working joints of the auxiliaries. The waste is appalling. It reaches sometimes to an extent that would seem impossible to the shore engineer. Usually the chief engineer establishes a daily allowance, which is placed in the supply tanks by the store-room keeper or donkey man. But if bearings commence to run hot, he frequently is the chief offender, literally smothering the journals in oil, increasing the allowance or taking off all restrictions.

As there is no convenient supply house within reach, thousands of miles from port, and as owners and superintending engineers are usually chary about furnishing large supplies to start with, any unusual waste of lubricants becomes exceedingly serious. More than one tramp has been obliged to break up the voyage to put into port for a new supply of oil, and it has repeatedly occurred that men-of-war were obliged to leave the blockading or cruising ground to lay in—not more coal or provisions or ammunition, but just oil.

These considerations emphasize the value of using non-fluid oils for lubrication on board ship, to increase the efficiency of oiling and in order to minimize waste. Greases and soap-solidified oils have been, and are still, used to a large extent, particularly on main bearings, spring and thrust bearings of the main engines and other principal auxiliaries.

In many ships the spring bearings of the shaft alley have open boxes, which are filled with a solid grease, through which solid brass pins are thrust to contact with the shaft, being kept in place by enlarged heads. Friction on the shaft heats these pins, causing the grease around them to flow to the journal. If the bearing should run hot—which very readily occurs with a box frequently left open by carelessness, and thus becoming a receptacle for dirt—and be not caught in time, the whole mass of grease is melted, leaving the unsupported pins to fall between the cap bearing and the shaft, where they are pinched and abraded, causing no end of trouble.

Generally speaking, soft solid lubricants should on no account be fatty oils or greases. They are commonly made by emulsifying animal and vegetable fats with soap and water, or thickening mineral oils with soap. Ordinary lime, soda or lead soaps are used, frequently containing an excess of

caustic soda, which is converted into carbonate of soda and becomes liable to cut the bearings. Another danger is that free fatty acids are often contained in such greases, which attack the metallic substances with which they come in contact, and cause glands to leak if used on rods or valve stems passing through stuffing-boxes. A more common, in fact universal, trouble with soap-solidified mineral oils is that, when the bearing grows at all warm, the mineral oil runs away, leaving the soap in the box, like a sponge squeezed dry of water. This forms a nucleus for the adhesion of any dirt or abraded metallic particles, soon making a hard, gummy mass, spreading out as a layer or coating over the shaft or pins, increasing the friction and soon inviting cutting. The best authorities recommend that greases be never used except on slowly-moving machinery. Modern transatlantic liners run up to 950 feet of piston speed, and swift power boats attain 1,200 feet per minute. This would indicate how little greases are in place on marine installations.

For spring and thrust bearings, the heavier grades of non-fluid oils are ideal, especially if used in connection with patent cups having a wire net screen and a lidded box cover. Frequently, oil is thrown off in fine drops by centrifugal action of rapidly turning shafts, which could not happen if the open boxes were lidded and closed.

These non-fluid oils, having all the advantages of the soft or semi-solid form of unguents without any of the above-mentioned defects of soap-solidified greases, offer an additional advantage peculiarly fitting them for use in main bearing compressive cups, on crank and cross-head pins, and especially for "make-up feed" supplied by hand with squirt cans. This is the property these lubricants have of adhering to metal surfaces with a force far in excess of that of regular fluid oils. Why this should be we are not able to explain. Suffice it to say that it is an undoubted fact, borne out by many tests and much practical use. This, and the considerable viscosity, cause the non-fluid oils to leave the squirt can drop by drop, instead of in wasteful streams, so that the excited oiler has a chance to readjust his aim at the elusive crank-pin cup before half of his can has been emptied into the bilge. After these oils have reached the journal, their peculiar property of adhesion to metal prevents their rapidly running through the bearing at the ends. They spread over the journal, interposing a thin film of oil between the bearing surfaces, which is ideal lubrication.

The other element of ideal lubrication is to have each drop of oil go where it is needed, and no place else. In many modern ships a comprehensive unitary system oil distribution is adopted to insure this element as far as possible. Oil is poured into a main feed tank, from which it is conveyed by gravity or under pump pressure to the various journals through suitably adapted pipes. In a recent installation, multiple box oilers with outside drop supply the cross-head guides, cross-head and wrist pins; the crankshaft bearings are oiled by compression cups, and the eccentric straps by oil and grease cups, while the cylinders and valves are supplied by sight-feed oil pumps having trip and rod connections to the engine. Though central distribution systems are growing in favor with superintending engineers, they have not succeeded in displacing the squirt can. Many old-time engineers and oilers cannot be restrained from wanting to *see* and *feel* the oil going in. They are a very conservative people. In spite of all the improvements in mineral oils, their relative cheapness and freedom from acids, the old timer would not think of leaving port without his private demijohn of —— castor oil, the standby in moments of real trouble.

Central distribution systems have been successfully fed with grease. That is to say, they were successful in having the grease reach its places of operation, though the gumming and high friction often following the introduction of grease decreased the value of these installations. But the experience shows how valuable similar systems would be for marine practice if fed with non-fluid oils, which can be made of a consistency light enough to insure their ready passage through the oil tubes, while their absolute freedom from gum precludes the possibility of their clogging the pipes—a most common and serious incident of all oil distribution systems. Forced feed types of lubricators, such as the Penberthy, can be relied upon to propel non-fluid oils to places where it is very difficult to feed through gravity cups.

A very common defect of marine oiling arrangements is the insertion of feed tubes at one end of the bearing, instead of at the middle. Even when placed at the middle, one end of the journal is often poorly supplied if the ship happens to be much down by the head or stern—a contingency from which shore plants are quite free. If the oil-feed tube is at the forward end of a journal, and the ship trims by the head to a considerable degree, it may be quite impossible to keep such a journal cool without constant hand oiling. For this condition of varying trim, non-fluid oils offer special advantages, because they do not run readily, and they do their work where they are placed, being spread from end to end of the bearing by actual wiping of the revolving journal.

An interesting comparison run was made two years ago on board the Clyde Line steamer *Apache*, using fluid and non-fluid oils. Using the same bearings for two periods of 54 hours each, it was found that 2½ pounds of non-fluid oil effected the same lubrication as 2½ gallons of fluid oil. As the cost of non-fluid oil was 10 cents a pound, the total was 25 cents (1 shilling) for the run; while the fluid oil cost 40 cents a gallon, or $1.00 (4 shillings) for the run. The test showed a saving of 75 percent on the direct cost of lubricants by using non-fluid oil. The results were so satisfactory that the Clyde Line has continued using non-fluid oils on the *Apache* ever since.

In Parsons' marine turbine engines, the two main bearings are usually kept floating in oil under a pressure of from 5 to 10 pounds. If ever the metals should come into intimate contact, the friction would soon destroy the entire machine, as the white-metal lining of the bearings would run out, throwing the shaft out of alinement, which, with the very small clearance between rotor and stator blades, would inevitably result in the two sets stripping each other. Spring bearings of turbine engines are supplied with grease and a liberal supply of water. In the thrust bearing, less trouble is experienced than with those of reciprocating engines, as the propeller thrust is counteracted by the end thrust of the steam on the turbine shaft.

Engines of motor boats are usually supplied with mechanical lubrication, having a pump feed to every point. For this class of engines non-fluid oils are particularly adapted, as the mechanical details are very similar to those of high-powered automobile engines, for which these oils have proved especially suited, being used exclusively by some forty automanufacturers. The parts are so many and move so fast that make-up feeding by hand squirters is quite out of the question; and any oil used must tenaciously stick to its journal until consumed, or it will be thrown off or worked out, leaving the bearing metal to metal. As these motor boats are ordinarily pleasure boats, it is especially desirable to use oils which will not splash or spatter about.

Whatever type of boat or engine be considered, one is forced to the conclusion that improvements of a radical nature on the methods of supplying oil, and in the nature of the oils used, is urgently needed in marine engineering. Says Thurston: "The art of economical employment of lubricants consists mainly in the determination of their adaptation to specific purposes, and in the application to each machine or each part of a machine on which pressure of lubricated surfaces of widely differing

amount is found of precisely that quality of unguent which is best adapted to that particular place, and, above all, applying it in the best possible way." Before becoming a professor, Thurston was a distinguished marine engineer. Considering the prevalent defects of marine lubrication, one is inclined to believe that in writing the words just quoted he must have had marine engines in mind.

G. P. Hutchins.

PETROLEUM GREASE AS COMPARED WITH ANIMAL GREASE.

Manufacturers of lubricating greases in the United States seem to have ranged themselves into two distinct and opposed classes. One class, which we shall call "Class A," puts out a grease produced entirely from animal fats; the method of applying which is based upon its power of changing consistency under increase of temperature. That is, the grease is quite solid in the cups until the heat of friction from the bearing becomes sufficiently great to melt it, and thereby enable it to flow down upon the journal.

The second class manufacture greases from mineral oils entirely, and the aim is to produce a grease that shall not change consistency under any range of temperature up to 600 degrees F. or thereabouts. The chief exponent of these principles manufactures eight separate densities of grease, ranging from a free-flowing liquid to a permanent solid. These densities are absolutely unaffected by variations of temperature within the limit named. The application is from pressure cups, and when pressure is applied the flow is uniform and certain.

Now, as to the relative economy of the two—let us consider first, Class A, the animal greases which will not flow until made liquid by heat from the bearing. We know that one British thermal unit is that amount of heat required to raise the temperature of 1 pound of water through 1 degree F. We know also that to produce this tiny amount of heat 778 foot pounds of energy are needed. When one begins to calculate, even mentally, the probable amount of heat of friction required to keep this grease flowing upon all the bearings throughout a machine shop, the fact is made clearly evident that true economy cannot lie in this direction.

A second proof of the same point is found in comparing the respective coefficients of friction obtained from the various greases, under test at Cramp's shipyard.

The lowest result obtained from any grease of Class A was 0.006, while Keystone (petroleum) grease gave a coefficient of 0.0034, thereby showing that only about one-half as much power was consumed in overcoming friction as in the first-named instance. Furthermore, it was proved that during one hour's running under severe conditions, 130.6 grams of "Class A" grease were consumed, while under similar conditions only 14.4 grams of the petroleum grease were consumed. It was shown also that, under prolonged test, the greases of "Class A" vaporized, and become so inefficient that the test had to be stopped; at no time, however, did the competing grease show any change of density or loss of efficiency.

Two tests by the chemist of the William Cramp & Sons Ship & Engine Building Company were made in 1906 and 1907 under similar but not identical conditions. In each case the test was in competition with other lubricants which are not here named. The tests were made on the Cornell oil testing machine, designed by Prof. R. C. Carpenter,* and finally adopted by the United States Government as a standard device for testing lubricants. Its essential features are a shaft and journal revolved by belt and pulleys from the power shaft; bearings, the pressure upon which may be regulated at will; a pressure indicator to register the load on the bearings; a speed indicator to give the revolutions per minute; a thermometer to register the change in temperature of the journal and bearings as the test progresses; and a scale beam on which the frictional resistance is recorded. The coefficient of friction is found by dividing the frictional resistance by the total load on the bearings.

* Cornell University, Ithaca, N. Y.

In the first test an analysis of Keystone grease showed 0.14 percent of free fatty acids, with no free mineral acids, rosin oils, talc, graphite or clay. The sample was stated to be entirely free from deleterious substances, such as would cause its decomposition, or would have a detrimental effect upon metal surfaces. The test was conducted for one hour and thirty minutes, readings being taken after the first thirty minutes, at which time the bearings were assumed to have reached a constant temperature. The grease was fed from a hand-pressure cup of 3 ounces capacity, by applying a uniform pressure at intervals of five minutes.

This test is stated to have been characterized by the smooth running of the journal, the uniformity of its temperature and a low coefficient of friction. The total pressure on the journal was 1,500 pounds; its area was 14 square inches, and the pressure per square inch, 107.1 pounds. It was revolved at 450 revolutions per minute. During the test the temperature of the room rose from 82 to 83 degrees, the average being 82.4; the temperature of the journal rose from 160 to 174 degrees, the average being 170.8.; and the average difference between the temperature of the journal and that of the room was 88.4 degrees. The friction decreased from 10.5 to 7 pounds, the average being 8.5 pounds. Its coefficient decreased from 0.0070 to 0.0046, the average being 0.0056.

The second test was on the same journal, with a total maximum load of 3,000 pounds and a pressure per square inch of 214 pounds. The revolutions, as before, were 450 per minute. This test was continued for about two and one-half hours, readings being taken during the last two hours. The load during the first hour under observation was only 2,000 pounds, or 143 pounds per square inch. During this hour the temperature of the room increased from 70.2 to 72.8 degrees, the average being 71.2. The temperature of the journal increased from 121 to 123 degrees, the average being 122; the difference between the two averages being 50.8 degrees. The friction decreased from 9 to 7.2 pounds, the average being 7.8 pounds; while the average coefficient of friction was 0.0039.

During the last hour, with a load of 3,000 pounds, the temperature of the room increased from 70.2 to 72 degrees, the average being 73. The temperature of the journal increased from 124 to 138 degrees, the average being 133.75. The difference between these two was 60.75 degrees. The friction decreased from 10.9 to 9.5 pounds, the average being 10.2 pounds. The average coefficient of friction was 0.0034.

W. R. McLain.

FLAKE GRAPHITE.

The conditions of marine engineering are, as we all know, different from those of stationary engineering. In marine work the first necessary consideration is that the working units must be confined in as small a place as possible. The units must be worked in varying stretches of 24 hours each. There are no emergency units that may be thrown in, in case anything goes wrong. The load is fairly constant, a steady, long, hard pull. There is no chance to shut down for repairs. Railroad men tell us that the life of the locomotive is very much prolonged if it can have an intermittent run, rather than a long, steady one. We may judge from this what a strain marine service puts on an engine.

Friction.—Wherever there is a mechanical movement, friction has to be overcome. This is done by interposing between the moving parts a substance which will separate the parts from each other (and has the least friction in itself). There

are three general classes of lubricants used—fluid, semi-fluid and solid. The writer will not attempt to discuss fluid or semi-fluid lubricants, because this is a subject which would cover many chapters, but will point out a few of the disadvantages of fluid lubricants for marine service, particularly in regard to steam engine cylinder lubrication.

Oil in steam engine cylinders, as many marine engineers have said, is a very "great curse," it being impossible to separate all the exhaust steam. As a consequence, some will find its way back into the boilers. The disadvantages of oils in a boiler are:

1. They have a tendency to attach themselves to the hottest places.

2. They are poor conductors of heat, and if there is any scale-forming material in the water it will collect.

3. If the oils contain impurities a chemical change will occur (especially in the presence of superheated steam), forming a destructive emulsion.

Solid Lubricants.—Anything which will reduce the amount of oil consumed, or entirely obviate its use in cylinder lubrication, is welcomed by the progressive steam engineer. A lubricant that has proved successful in this particular is flake graphite. The many qualifications of a perfect lubricant possessed by flake graphite especially adapt it for all lubrication, particularly in marine work.

It is unaffected by any degree of superheat or cold encountered in any class of lubrication. It will not gum, leave a sediment or injure the working surfaces. It is a good conductor of heat. It will stand the greatest load per square inch, with a marked reduction in friction. It does not offer the resistance to motion that is inseparable from the viscosity of an oil or grease that would stand like pressure.

If a metal, no matter how carefully polished, is examined under a microscope, it will be found to contain many small irregularities—the real cause of friction.* It is the scraping of these irregularities, one over another—the constant cutting or wearing—which is so productive of hot boxes, cut valves and cylinders.

The thin, tough flakes of graphite attach themselves to and build up these irregularities, filling in the low spots and forming over all a thin, impregnable, veneer-like coating of marvelous smoothness. When a sudden lurch or pitch comes, this graphitic coating will keep the metal surfaces from coming into contact with each other, and prevent the damage which might be done before the lubricator could deliver more oil.

Flake graphite may be introduced to the cylinders either with oil or by condensation of steam. It has no injurious effect in the boilers if some escapes the condenser and gets carried back. It will be a benefit rather than a detriment, as the flakes will become attached to the metal surfaces and prevent pitting, keeping foreign matter from taking hold. The heat transfer will not be affected, for graphite (as before stated) is a very good conductor of heat.

Semi-solid lubricants should be used wherever practicable, and have the following advantages over oils:

1. They are used only as needed, and form a protecting collar, after doing their work, which will keep dirt and grit from working into the bearings.

2. They are more cleanly than oils.

3. The fire risk is very much reduced.

4. They are cheaper than oils.

Care should be exercised, however, in selecting these, as they should be adapted for the work. Their lubricating value is always increased by adding flake graphite (it is always better to use graphite greases which are compounded by some reliable company, as they will be found to contain correct proportions of graphite for the work required of them). Tests by the late Prof. Thurston, Prof. Kingsbury and Prof. Goss, all show that friction is reduced by adding flake graphite. These tests have more than been proved by engineers. A well-known commander in the United States navy said:

"One of the first orders I gave on joining this ship was forbidding the use of oil in any of the steam cylinders, and to enforce this order I had all the oil cups removed from the steam pipes leading to the cylinders, so that it was impossible for the men to use oil. When these cylinders were examined, at intervals of from three to six months, I simply had them wiped out with a little waste and saturated with vaseline and graphite; and I must say that I have never seen the cylinders and piston rings in better condition than they were on this ship during my three years' tour of duty.

"I made a personal examination of the different cylinders whenever they were opened, and they were in perfect condition—never so much as a scratch—the walls being as smooth as mirrors. I can safely say that the use of graphite alone in steam cylinders gives excellent results, for if oil is used the oil goes through the exhaust into the condenser, and into the boilers and forms an acid, which attacks the metal of the boilers and causes them to deteriorate very rapidly."—*Graphite*, March, 1907. L. H. Snyder.

* It is related how a convict cut the bars of his cell window by using a piece of yarn and fine sand dust, the whole wetted by saliva—illustrating how much damage may be done to bearings by the lubricant being laden with metal particles.

Internal Lubrication of Marine Machinery.*

BY H. C. DINGER, LIEUT. U. S. N.

The loss due to the friction of pistons, plungers, valves and their respective rods at stuffing boxes forms a large part of the total loss caused by friction; and the question of keeping these internal parts in proper condition to reduce this loss to a minimum and prevent their wear warrants considerable attention by those to whom the care of marine machinery is entrusted. New difficulties in lubrication have been met in the use of high steam pressures and superheated steam, due to the very high temperature at which the ordinary lubricants are vaporized. The use of greater piston speeds and pressures on wearing surfaces likewise has added to the problem.

Remedies suggested to secure the nearest to the desired conditions are:

1. Selection of best materials, the friction between which is a minimum.

2. Efficient design.

3. Good and accurate workmanship.

4. Care and treatment to prevent the deterioration of the wearing surfaces.

5. Lubricants.

PROPER MATERIAL.

The materials for the internal wearing parts should be such that the coefficient of friction is as small as possible. Then a very smooth and hard surface can be obtained, and one that requires relatively little lubrication besides the moisture of the steam. Hard, cross-grained cast iron, wearing on itself, seems to meet these conditions better than any other practical combination of metals. When the cylinder and valve-chest liners are made of this material, and with cast iron rings well fitted, an extremely hard and smooth surface is the result, without applying any lubrication but the moisture of the steam. The material should be as hard as it is possible to work it, the efficiency of the wearing surface depending in a great measure on its hardness.

EFFICIENT DESIGN.

The following points of design will affect smooth running very materially:

The spring rings or snap rings should exert a uniform and not an excessive pressure, and their surfaces should not be

* Reprinted from page 503, October, 1903.

too great. Thus, if a ring 1 inch wide will be efficient in keeping a piston tight, making the ring 2 inches will only add friction.

Fitting relief rings on slide valves, and balance pistons on piston valves, always reduces friction, and is the general practice of to-day.

The framing and other parts of the engine must be properly braced and stiffened to guard against vibration and the movement of the ship.

The stuffing-box packing should be designed to allow some side play, so as to follow the rods when they become somewhat out of line.

WORKMANSHIP.

Good workmanship will insure all parts being in line, all surfaces true and all parts accurately fitted together. This includes boring the cylinders true and finishing the valves and seats to a true surface and the rods to a uniform section. If there are any material discrepancies in these points good results cannot be expected to follow.

CARE OF SLIDING SURFACES.

This is accomplished by keeping all parts in line, preventing rusting, pitting and scoring of cylinders, flats in rings or rods, and cutting of all wearing surfaces.

If the cylinders or rings are allowed to rust the true surface is at once destroyed, and small particles of rust will grind and cut away the wearing parts. Rusting in the cylinders is caused by the presence of both air and moisture. Moisture may be removed by well draining the cylinders and all steam pipes connected therewith; by the avoidance of pockets that cannot be drained of water, and by running the condenser for some time after the engines are stopped, so that all possible vapor is drawn out of the engines. When an engine has thus been efficiently drained, the low-pressure exhaust should be kept closed, especially if the condenser is to be run at any time. In case there is no exhaust valve, and it is desired to run the condenser, it is advisable to put the low-pressure valve on its center, and thus prevent the vapor from the condenser from backing into the cylinder and causing rust. Leaky stop and throttle valves will, of course, present conditions to allow rusting.

To keep out air, all parts of the engine should be kept closed. Close the drains which open to the atmosphere, indicator cocks, etc., as soon as the engine is shut down. The cylinders of auxiliaries are most likely to suffer from rust, due to leaky or partly closed valves, open drains and the presence of various pockets where water can collect.

When engines are to stand unused for more than a couple of days, and after any lengthy run, the cylinders should be opened and wiped out with kerosene. This removes all rust, moisture or other deposits that may have collected. Then adding a coat of vaseline will protect the surfaces from further rust or corrosion, as well as give them a good lubricant.

Pitting in cylinders and internal surfaces is caused by acids which may be contained in impure oil, or from the action of oily deposits consisting of dirt, oil and rust. Air, collecting in pockets and becoming heated, may also cause this.

Scoring is caused by hard particles left in the cylinders and by the edges or ends of the rings nipping the cylinder walls, resulting from countersunk bolts let in too far, shoulders worn in the cylinder when the piston does not overrun, or rings overrunning counterbore, due to lack of adjustment. Slightly rounding off the edges of the rings might prevent nipping, and providing efficient keepers for the ends will prevent the ends from vibrating or the rings from nipping the walls. Excessive pressure on some parts may cause the surface to abrade and produce a flat. If the rings do not fit well, the wear will be only on certain portions; for although the ring in a manner adjusts itself, yet when moved at all the fit becomes worse than ever.

The piston rod being out of line will also cause excessive wear on one side of the cylinder and piston rod. When boilers foam, particles of dirt contained in the boiler water pass into the engines, and there raise havoc with all moving surfaces.

LUBRICANTS.

Vegetable or animal oils must never be used, on account of the acids, which, being easily driven off by heat, cause corrosion in the boilers. Mineral oils are largely used, but have a bad effect on the heating surface of boilers, causing lack of efficiency, burning, etc. Oils too freely used also cause piping, pump valves and seats to deteriorate, joints in piping to leak, condensers to become less efficient on account of oily deposit, and in general cause an increase in repairs and falling off in economy.

With very high pressure or superheated steam ordinary oils are vaporized, or at least their lubricating value is greatly reduced, so that, as in the case of gas engines, lubrication has become a most important question. When somewhat moist steam is used, the moisture in the steam acts as a lubricant, especially with cast iron. With parts well fitted and steam not too dry, vertical cylinders will run satisfactorily without any lubricant except that applied when the cylinders are opened; but a satisfactory lubricant will very materially lessen the friction and wear.

Flake graphite has the peculiar properties of not being affected, either chemically or physically, by any temperature encountered in a cylinder. It is not easily carried away from the wearing surfaces, can stand any pressure, and requires only an infinitesimal clearance space between surfaces. It has a high lubricating value, and hardens and improves the wearing surfaces by filling up all the minute cavities and irregularities in the surfaces, giving, in a short time, a beautiful, hard-polished surface, which requires relatively little lubricant.

Graphite may be applied in the following manner: Whenever cylinders or valves are overhauled, mix graphite with vaseline before applying to the surfaces, which insures a general distribution. On starting up, introduce graphite through an oil cup or indicator pipe. This can be done in a dry state, using an oil syringe, or the graphite can be mixed with water and put in just like oil. Adding it to cylinder oil adds to the lubricating value; but if best results, viewed from the standpoint of boilers and condensers, as well as engines, are to be obtained, no oil should be introduced into any steam cylinder on board ship. While running, graphite can be added in the same way; but very little is needed, since it quickly distributes itself over the surfaces and, unlike oil, it remains there. Whenever there are indications of the cylinder walls "squealing" a little graphite should be added. Some cylinders lubricated in this manner, that have not had a drop of oil introduced for years except that which might have come from swabbing rods, on being opened are found perfectly smooth and as bright as mirrors. The surfaces have a very fine coating of graphite, which keeps them from being dry and prevents abrasion.

The same results are obtained with valves and their seats—the surface is made smooth and hard, scores are filled up, and a tight and easily worked valve is the result.

In order that the piston rod may work with little friction in its stuffing-box it must be well lubricated. Most patent metallic packings have an oiling arrangement, but this should be supplemented by swabbing the rods. The addition of a little graphite to the stuffing-box cylinder oil will greatly improve its lubricating value, and also serve to develop a hard and smooth surface, which is so essential to steam-tight working.

The packing that allows for side movement will keep the

rod from wearing, and preserve a tight joint, much better than those which do not allow such play. Small rods, such as valve rods and rods of auxiliary engines, which in many cases have no separate oiling device, should be swabbed to prevent cutting, or the wearing of the rod to a flat or taper, as well as to reduce friction. The primary feature of keeping a stuffing-box tight is to keep a true cylindrical rod, and the peculiar properties of graphite produce a hard and smooth surface.

The small and often delicate secondary valves of steam-pump valve gear are made to fit quite tight, and often they become hot and dry and consequently stick. If oil is used in these, it gums on the surface, and this causes the valve to stick. Slight rusting also causes cutting, which interferes with proper running. The best treatment for these parts is: (1) Frequent overhauling, wiping off all parts with kerosene to clean, remove and prevent rust, and supplying graphite to protect and develop the wearing surfaces. (2) Adding a small amount of kerosene with graphite added occasionally or when the valve does not work properly. Kerosene serves to cut out and prevent rust; it has also no bad effect on the heating surface of the boiler.

It is often stated that pumps will not run without oil, but it is a fact that pumps using oil do not run as well as other pumps in which nothing but a little kerosene and graphite has been used for a long period.

WATER END OF PUMPS.

The lubrication of the water cylinders of pumps is frequently entirely overlooked. A great many pumps receive their lubrication naturally, as in the case of air and feed pumps, from the oil in feed water; bilge pump, from the oil contained in the bilge. But those pumps working on clean salt water—sanitary, distiller and auxiliary condenser circulating pumps—do not have these sources of lubrication. Salt will deposit itself in some degree, and is at once a cutting agent to plungers and pump cylinders.

Such pumps can be lubricated by placing a little grease, mixed with graphite, on top of the glands. This at once lubricates the rod, and some of the lubricating material will find its way to the surface of the cylinder, thus reducing friction and wear. The abnormal wear of plunger rods working in clean salt water may have often been observed.

These notes are the results of observation and investigation of sea-going experience, and, as such, view the matter from a practical standpoint. There is no doubt that if the question of internal lubrication were well considered and investigated by those operating marine machinery, great reductions in overhauling, wear and tear, and anxieties in attendance would result.

The Merchant Tonnage of the World.

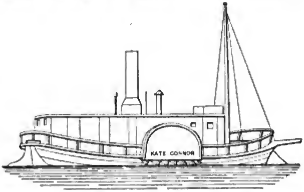
According to *Bureau Veritas*, the total number of sailing vessels of 50 tons and upwards afloat Jan. 1, 1908, was 25,879, with a total net tonnage of 7,245,608. One year ago there were 26,579 vessels, with a net tonnage of 7,550,273, and 27,122 vessels two years ago, with 7,620,679 net tons. There is thus seen to be a steady decrease in both number and tonnage, the loss in tonnage in two years having been 375,071, or about 5 percent. The average size has decreased from 281 tons in 1906 to 280 in 1908, having been 284 in 1907.

The number of steamers of 100 tons and upwards afloat at the present time is given as 14,985, with a gross tonnage of 32,169,350, as compared with 14,656 vessels of 30,256,336 gross tons one year ago, and 14,018 vessels of 28,369,140 tons two years ago. This shows a gain in tonnage in two years of 3,800,210, or 13.4 percent. The average tonnage has risen from 2,024 in 1906 to 2,065 in 1907 and 2,147 in 1908.

The First Steamboat on Great Salt Lake.

In the fall of 1868, General P. E. Connor, who had previously been in charge of the government station and troops near Salt Lake City, obtained a contract with the Union Pacific Railroad, which was then building, for the supply of ties. The road ran around the north end of Great Salt Lake, where there was no timber (nor, in fact, anything else), and the ties were obtained from the mountains south of the lake, a distance of about 85 miles, from shore to shore.

His proposition was to load the ties on flatboats, and tow these over and back by a steamboat, leaving the flatboats for loading and unloading, and keeping the steamboat continually



THE IMPROVISED PADDLE STEAMER KATE CONNOR.

at work. Accordingly, he employed a London boat builder, G. Haywood, of Salt Lake City, to build the steamboat, which was 55 feet long and 18 feet beam, with 5-foot guards.

The boat was propelled by paddle wheels, with an engine consisting of the steam end of an old steam pump, geared to the wheel shaft. A boiler was obtained from San Francisco. The machinery was put in and arranged, and the boat run out of the river by the writer. She was called the *Kate Connor*, after a daughter of the proprietor. She started on Dec. 11, 1868, and ran across the lake to her depot at the south end on the following day. She afterwards had a larger engine and boiler put in, and made a number of trips across the lake in 1869, but was not a financial success.

As an illustration of the paucity of resources at that time, the engine had no globe valve, and such a thing could not then be obtained in the territory. Eventually a 2-inch brass plug cock, which had been brought in for the sugar works, was found, and purchased for $15, and used as a throttle valve.

Wm. J. Silver.

At the annual meeting of the American Ship Windlass Company, recently held in Providence, R. I., Robert S. Riley, who for the past year has been the general manager of the company, was elected its president. The reports submitted showed a satisfactory condition of affairs, and the company voted to ask permission from the State Legislature to increase its capital stock from $100,000 to $200,000 (£20,550 to £41,100).

The American scout cruiser *Chester*, propelled by Parsons turbines, recently made a trial trip record of 26.52 knots for four hours. Her sister ship *Birmingham* (reciprocating engines) made 24.32 knots on a similar trial. Both were tried at 3,750 tons displacement, with loads including 475 tons of coal, the bunker capacity being 1,250 tons. This compares with a normal coal supply of 160 tons on the eight British 2,900-ton scouts, and with a bunker capacity of but 380 tons. These eight vessels made trial speeds ranging from 25.02 to 25.88 knots.

INTERNATIONAL MARINE ENGINEERING

Published Monthly at

17 Battery Place New York

By MARINE ENGINEERING, INCORPORATED

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President

E. L. SUMNER, Secretary

and at

Christopher St., Finsbury Square, London, E. C.

E. J. P. BENN, Director and Publisher

SIDNEY GRAVES KOON, Editor

Branch Offices { Philadelphia, Machinery Dept., The Bourse, S. W. Anness. Boston, 170 Summer St., S. I. Carpenter.

Entered at New York Post Office as second-class matter.

The edition of this issue comprises 6,000 copies. We have no free list and accept no return copies.

Notice to Advertisers.

Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 5th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 1st of the month.

Lubrication.

All machinery requires a certain amount of lubrication, in order to keep the parts in moving contact from scoring each other, or from becoming heated in service. The extent and character of this lubrication depend entirely upon the size, character and relative velocity of operation of the parts in question, and have to be determined upon, in general, for each particular case separately.

Many different kinds of lubricants are used, some of which, while excellent for one class of service, are totally unsuited to other work. Thus, the lubricant which is used for a fast-running spindle is necessarily thin and light; while that used for a heavy and slow-running journal, particularly where great pressure is employed, must necessarily contain much more body than the other. In the early days of marine engineering it was quite usual to employ fats and tallows to keep the parts working smoothly. In the present days of high pressure and great powers, to say nothing of high temperatures, these early lubricants are totally ruled out of court and mineral substances substituted.

The most prominent lubricants at present in use in the marine service may be divided into fluid and non-fluid mineral oils, greases of various types, and, for heavy uses particularly, flake graphite. In another column will be found a series of papers prepared for us by advocates of several of these kinds of lubricant, which we are publishing side by side, with the idea that a brief discussion of the various points of the several types may be of benefit to our readers. Each paper has, necessarily, its own personal bias; but the group, as a whole, may be said to represent, fairly, general practice on the subject, and not to be in the interests of any one manufacturer.

The Turbine Engine.

In another column a correspondent has taken up the ever-present subject of the relation between rotary and reciprocating prime movers, from a point of view which, to many, will doubtless be novel. It is quite apparent from his paper that he has some lingering sympathy for the reciprocating engine. In fact, while not in the least discrediting the turbine or the splendid results which have been achieved by it, he points out that, were equal refinement resorted to in the designing and construction of the steam engine of the piston type, equally good results would be achieved. The subject is one of great interest, particularly in view of the present prominence of the turbine question, and is one which presents many points which might well be worth looking into.

When it comes to a question of weights, however, always assuming that we are designing for a considerable speed, the subject takes on a totally different aspect; for it is quite possible to build turbines of very good efficiency, and high adaptability to the particular circumstances of the case, which will, in general, weigh markedly less than the reciprocating engines which they displace. In each case the very extremity of economy of fuel consumption will demand great weight, whether the turbine or the piston engine be employed; but for equal results, it seems to be established, beyond the peradventure of a doubt, that the steam turbine is without a peer for large powers when it comes to a question of weight.

The balancing of a steam engine of the piston type may frequently be done to such a high degree of refinement that vibration is reduced to a minimum. In this respect the turbine, as usually built, is also a splendid device. In either case, the operation of the propeller will throw masses of water against the stern as the several blades in their rotation approach the ship, and the vibration caused by this continual bombardment of the hull by relatively small masses of

water is bound to make itself felt, especially in the neighborhood of the portion affected. The propeller is intended to discharge, directly aft, all of the water which comes to it, and upon which it has acted. No propeller does this in practice, some of the water being thrown out sidewise by centrifugal action; and just so far as the propeller fails to impart complete astern motion to this water does it fail in the best efficiency of which it might otherwise be capable. The ill effects are thus double—a loss in propulsive effect and an augmentation of the causes of vibration, affecting the whole resonant structure of the ship. This feature of the subject is taken up in one of our clippings this month, in which a certain discontent is referred to regarding the fact that the large turbine vessels crossing the Atlantic are not so totally free of vibration, especially near the stern, as some people had expected they would be. So long as the propeller maintains its present form, it will probably be totally out of the question to do away entirely with something of this sort, even though the engine itself be so perfectly balanced in all its working parts that not the slightest amount of vibration can be traced to this source.

Shipbuilding Details.

Shipbuilders, as a rule, are very secretive people. It is difficult to obtain, in most cases, anything of a thoroughly technical character regarding either ships or their machinery, and the few instances in which the builders are sufficiently open-minded to give out information of this sort are so relatively rare as to stand out sharply by way of contrast. Occasionally, however, something of the sort is available, either directly from the shipbuilder or from a naval architect who has developed the plans, which are later put into execution by an establishment with which he is not officially connected.

A very good example of the latter class will be found this month in the description of two steam lumber schooners, built on the east coast of the United States for service in Pacific waters. These vessels are small, and, were it not for some rather unusual features in their construction and equipment, they would scarcely call for more than passing comment. We have been enabled, however, through the courtesy of their designer, to place before our readers some splendid details in drawings and text, showing the methods of construction of a type of vessel which is becoming quite prevalent in the particular trade for which these two were designed. These details are much more extensive than it is usually possible to obtain regarding any ship structure, and, as such, are all the more valuable on that account. It is frequently possible to obtain general hull drawings of a vessel under description, and we even occasionally find available a 'midship section showing the principal scantling members. In some cases, however, these members themselves are not available, though the 'midship drawing, denuded of them, may come to hand. In only a very few cases is it possible to get such detail as has been furnished us in the instance under consideration.

It is only natural that a shipbuilder who has devoted time and energy, as well as capital, to the establishment and upbuilding of a shipyard and certain methods of construction, should wish to jealously guard all such items of detail from his competitors. In many of the cases, however, much information of value could be divulged without going into the region of the particular practice and special secrets of the establishment, and without much effort on the part of the shipbuilding establishment itself. It is very rare, however, to find such an establishment willing to give out even that which could be given without exposing their trade methods of construction; and this seems to be part of a legacy of secretiveness which has been carried along through the years as a portion of the assets and policy of the establishment. It is much to be regretted that such is the case, because the history of civilization has proved, time and time again, that the most direct and most valuable advances have come through a free interchange of ideas, and the adaptation of one method of producing the desired result where others, perhaps, have been tried with only indifferent success. It is perfectly easy for any one interested to learn nearly everything of value which his competitors are doing, even to the matter of details. Given the will, the way will certainly be found. This makes it all the more inexplicable why so much reticence should be observed with regard to the most fundamental features of a given structure.

In some cases this reticence is carried to an extreme limit, as, for instance, in the case of one firm to which we wrote, asking for the cylinder diameters and strokes of the propelling engine and a number of auxiliary engines in a vessel which they had constructed. Even such usual and general data as this were refused us, owing, apparently, to an iron-clad rule not to divulge anything which could possibly be of service to any other member of mankind, even though this service might not be in the slightest degree a detriment to the establishment in question. It strikes us that this policy, when carried to such extreme limits, is totally wrong, and that very little can be adduced in its favor. It is possible that, in some cases, a confidence may have been broken, and that an event of this sort has predisposed the managers against any sort of publicity other than that of glittering generalities, with which the daily newspapers delight to deal. As a general proposition, however, the shipbuilder will find the technical journalist entirely willing to go hand-in-hand with him—to respect whatever confidences may be imposed—and to give out no more in the way of information than the builder is willing to have made public.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports, Feb. 10, 1908, the following percentage of completion of vessels for the United States navy:

	Tons.	Knots.		Jan. 1.	Feb. 1.
BATTLESHIPS.					
Idaho	13,000	17	Wm. Cramp & Sons	94 12	95 9
New Hampshire	16,000	18	New York Shipbuilding Co.	95.3	97.8
South Carolina	16,000	18½	Wm. Cramp & Sons	33.76	36 4
Michigan	16,000	18½	New York Shipbuilding Co.	37.9	41 6
Delaware	20,000	21	Newport News S. B. & D. D. Co	7.05	9 2
North Dakota	20,000	21	Fore River Shipbuilding Co.	12.7	17.5
ARMORED CRUISERS.					
North Carolina	14,500	22	Newport News Co.	96.	97.
Montana	14,500	22	Newport News Co.	91.31	93.4
SCOUT CRUISERS.					
Chester	3,750	24	Bath Iron Works	95 15	96 2
Birmingham	3,750	24	Fore River Shipbuilding Co.	93 71	96 2
Salem	3,750	24	Fore River Shipbuilding Co.	92.09	93.9
TORPEDO BOAT DESTROYERS.					
Number 17	700	28	Wm. Cramp & Sons	0 0	4.5
Number 18	700	28	Wm. Cramp & Sons	0 0	3.8
Number 19	700	28	New York Shipbuilding Co.	3 4	5 1
Number 20	700	28	Bath Iron Works	0 0	2 5
Number 21	700	28	Bath Iron Works	0 0	2 5
SUBMARINE TORPEDO BOATS.					
Cuttlefish	—	—	Fore River Shipbuilding Co.	99	99

ENGINEERING SPECIALTIES.

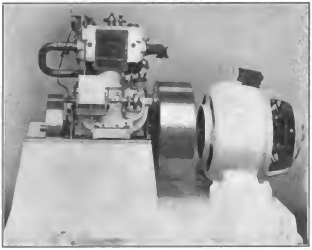
A Six-Cylinder Three-Hundred-Horsepower Motor.

The engine illustrated is placed upon the market by J. W. Brooke & Company, Ltd., Adrian Works, Lowestoft, and is designed to develop in six cylinders a total of 300 brake horsepower. Each cylinder is cast separately, with mechanically-operated valves placed on opposite sides. The engine is fitted with a high-tension magneto and high-tension synchronized ignition. The crank chamber is of cast steel, made in halves, and bolted together in the center for facility in machining. The crank shaft, which is 3¼ inches in diameter, is of nickel steel in one piece, and runs in bush bearings located between the successive dips. Two cam shafts are employed, one on either side of the engine, our photograph showing the admission valve side.

The cylinders are 10 inches in diameter with an 8-inch stroke, and are of cast iron. To economize space they are set askew on the crank chamber. Starting is facilitated by means of a one-third compression release device, and it has been found in practice that the engine will start in this way very readily. After once under way the full compression automatically comes into operation. One carbureter is employed for the six cylinders, this having been found preferable to using a separate carbureter for each cylinder. A metal-to-metal clutch is provided, operated by a lever. Lubrication is automatic.

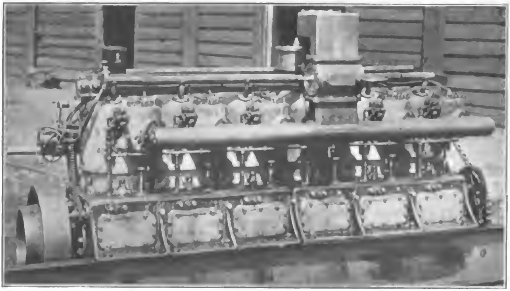
A Small Lighting Set.

The set illustrated is made by John I. Thornycroft & Company, Ltd., London, and consists of a small generator direct connected to a 6-horsepower petrol (gasoline) engine. This engine has a single cylinder, 4¼ inches in diameter, with a stroke of 5 inches, and is designed for operation at 1,000 revolutions per minute. It is especially suitable for use with



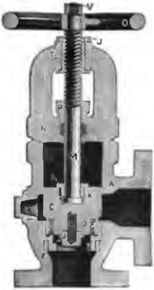
paraffin (kerosene), on which the brake-horsepower is stated to be 5.

The same motor, with slight modifications in the base, has been developed for the propulsion of small boats, but in its present illustrated form it is of particular interest, because of its simplicity and effectiveness as an outfit for lighting sailing vessels, motor and other yachts, and country houses.



An Improved Blow-Off Valve.

The cut illustrates an improved design of blow-off valve, which embodies a number of important features highly appreciated by users. Heretofore the seat has been so located that, as the disk approached it, there would be an accumulation of scale and sediment. The effect of this has been to cut out the bearing surfaces to such an extent that in a short time the valve becomes leaky. Various methods have been invented whereby the disk would fit tightly in the valve body, the object being to prevent the scale from passing on to the seat bearing after the disk had passed and cut off the inlet. This method, however, has not proved satisfactory, as the valve soon wears, and in a short time permits the passage of scale and sediment. These defects are said to have been overcome in this design. The plug fits snugly in a separate



and easily removable bronze casing, which can be readily replaced when worn. Any accumulation of scale or sediment that might remain on the seat, before the disk is brought in contact with it, is washed off by the water which passes around the plug when seating.

It will be seen that the plug *C* carries a reversible, double-faced disk *D*, secured to the plug by stud *H* and nut *J*. This plug is guided perfectly in the valve body *A*. The bronze seat ring *E* is screwed into a second brass ring *F*, the object being to make it possible to renew *E* very easily in case it becomes worn. At the back of the valve is a plug *B*, the use of which is to permit the introduction of a rod to clean out the blow-off pipe when desirable. The stem *M*, which raises and lowers the disk, is held in place by lock-nut *L*, which is prevented from unscrewing by non-rotating washer *K*. The threads of the stem operate within the bronze bushing in the top of the yoke, which bushing can easily be removed. The disk, having two Babbitt-faced bearings *G G*, can be replaced at small cost, or the user of the valve can melt out the old Babbitt and pour in new metal, and after this is faced off the disk is as good as new.

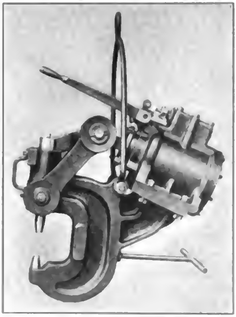
The valve, known by the trade name "Duro," is constructed and carefully tested by the Lunkenheimer Company, Cincinnati, Ohio, who claim for it extreme durability.

A New Albree Portable Riveter.

Where the work is heavier than the tool it is much more convenient and economical, if not absolutely necessary, to keep the work in a stationary position and use a portable tool. This practice is particularly desirable in riveting heavy and unwieldy structural and boiler work. The hydraulic riveter is not practical for this service, on account of the difficulty of providing high-pressure water lines and carrying away the exhaust water. An air-driven machine, however, similar to the one shown in the illustration, which is manufactured by the Chester B. Albree Iron Works Company, Allegheny, Pa., is admirably adapted for this work, as the air is conveyed to it by a rubber hose, and the exhaust takes place directly into the atmosphere.

The riveter illustrated has a 6-inch reach, will drive a ⅞-inch rivet, and weighs 850 pounds. When desired this machine may be equipped with the maker's universal bail, which will hold it suspended in any position. It will be noted that only a comparatively small cylinder is used, the necessary pressure being obtained by the toggle leverage shown, and as the rivet is driven by one squeeze the number of rivets the machine can drive is practically unlimited. Therefore, the amount of riveting that can be done is merely a question of getting the machine from one rivet to the next; in other words, the cost of riveting is almost entirely the cost of moving the machine.

To show what has been done with such a machine, under favorable circumstances, the astonishing record of 12,000 rivets



driven in ten hours' time is claimed. The work was a long plate girder, and the machine was suspended from a trolley on an overhead runway. The operator, with practice, had become very expert in moving the machine from one rivet to the next, the spacing being equal, and several heater boys keeping the holes ahead of the machine full of hot rivets. The rivets were ¾ inch diameter and driven hot, and the dies were replaced by cool ones at given intervals.

TECHNICAL PUBLICATIONS.

Massen-Distillation von Wasser. By Ludwig Bothas. Size, 5½ by 8¾ inches. Pages, 53. Figures, 8. Berlin, 1908; Julius Springer. Price, 2 marks.

This little work is divided into five sections, covering respectively the different methods of cleansing water; the construction and operation of water distilling plans; the conversion of distilled water to railroad service; the drinking water distilling plant of Baku; and an appendix giving a

bibliography of distilling plants and a number of illustrations.

The subject is taken up from the points of view of filtration, sterilization, distillation and chemical cleaning, and is based largely on Russian practice, the author being one of the government public works officers in St. Petersburg. In the specific case of the description of the plant at Baku, a population of 200,000 inhabitants is supplied with good drinking water in a portion of Russia where atmospheric precipitation is rare, and rivers and good springs in the neighborhood are entirely lacking. This has made it necessary to make use of water which, without treatment, would be totally unfit for drinking, and the results are said to have been entirely satisfactory with regard both to the chemical composition of the water as altered, and its adaptability to household uses.

The Naval Pocketbook. Edited by Geoffrey S. L. Clowes. Size, 3½ by 5 inches. Pages, 966 + xl. Numerous illustrations. 1907, London: W. Thacker & Company, 2 Creed Lane, E. C. Price, 7/6 net.

This is one of a series of annual volumes dealing with the navies of the world, and giving a vast amount of information regarding the individual ships of which those navies are composed. Beginning with the British navy, the various other fleets are arranged in alphabetical order, and under each heading the ships are grouped according to types and dates, battleships preceding coast defenders, after which come armored and protected cruisers, torpedo gunboats, destroyers and torpedo boats. The details given include the main dimensions of the ships; displacement; power; speed; coal capacity; in many cases details of the engines and boilers, such as the cylinders and heating and grate surfaces; a statement as to the armor protection for both the hull and the battery; a detailed outline of the battery itself; and in some cases certain portions of the weights, as of hull, armor, etc. Trial-trip results are given in many cases, as well as designed powers and speeds, and the whole work is annually revised and brought as nearly as possible up to date.

In addition to the lists of ships, etc., there are tables of heavy and light guns used in the various naval services, the particulars including the size, weight and length of gun, weight of projectile and powder charge, and such ballistics as the muzzle velocity, energy and perforation in wrought iron. A very complete table of the drydocks of the world, arranged in geographical order, follows; and there are a number of minor tables, for the conversion of measures, including trial-trip tables, etc.

The last section of the book consists of 136 pages of illustrations of the principal war vessels of the different powers. These are all line drawings and show the general distribution of battery and armor, there being in each case both an outboard profile and one or more deck plans. These are carefully drawn to scale, and are believed to be quite reliable. In each case only one ship, of course, of a given type is illustrated, unless there are important differences between such a ship and its sister ships. The number of ships illustrated is 136, but as each illustration serves to show the characteristics in general of from three to as many as ten ships, it might be stated that somewhere in the neighborhood of 500 of the most important vessels are here represented.

A History of the United States Navy. By John R. Spears. Size, 5¼ by 8 inches. Pages, 334 + xii. Illustrations, 22. New York, 1906: Charles Scribner's Sons. Price, $1.50 (6s.).

This history is compressed within the limits of a convenient volume, and deals more with details of the various naval actions in which the United States vessels have fought at various times than with the details of material development, such as would be found in a more technical treatise. The latter features are not passed over without attention, but the main idea seems to have been to present a history from the point of view of a narrative dealing with action, rather than with the results of study of types of ships and distribution of guns. The preface states that "it was in the belief that every history of the United States navy claims attention first of all as a hero story that this one was written."

Some consideration has been given to the facts and conditions which have from time to time created public sentiment in favor of the employment of the navy, or against it. Of particular interest in this connection is the story of the building of a navy to throw off by main force the thraldom under which, over a century ago, all civilized nations were paying tribute to the Barbary States on the Mediterranean coast of Africa. Attention is called to the influence upon naval construction of such epoch-making events as the battle between the *Monitor* and the *Merrimac;* and consideration is given to the effect that brilliantly fought naval battles have upon character.

The work is divided into thirty short chapters, beginning with the organization of the first navy during the opening months of the War of the Revolution, and carrying the reader through that war, the war against the African pirates, the brief war with France, the war of 1812 against England, the civil war in the United States, and the war with Spain. Owing to the great range of operations during the war of 1812 and the civil war, these are, of course, given most extensive treatment, and the illustrations covering ships, battles and commanders are especially interesting.

The Gas Engine. By Frederick R. Hutton, E. M., Ph. D., Sc. D. Size, 6 by 9 inches. Pages, 562 + xx. Figures, 241. New York, 1908: John Wiley & Sons. Price, $5. London: Chapman & Hall, Ltd. Price, 21s. net.

This is the third edition of a treatise on the internal combustion engine, using gas, gasoline (petrol), kerosene (paraffin), alcohol or other hydrocarbon as a source of energy. The work is divided into twenty-one chapters, the first four of which are devoted to theoretical and practical considerations regarding heat and energy, and the heat-engine cycle. These comprise nearly one-third of the volume. The next four chapters deal with engines using the various types of fuels, these chapters being descriptive, in large measure, and illustrative of the various types. The other chapters cover such subjects as the proportioning of mixtures, carburation, ignition, governing, the cooling of the cylinder, the treatment of the exhaust, the manipulation of gas engines, their performance and tests, theoretical analysis of the gas engine, experiments, costs of operation, etc. The most extensive chapter of all is that covering the theoretical analysis, this being not less than 139 pages, or practically one-fourth of the volume.

In this work, in general, the treatment of the design of engine parts has been omitted, partly because of the extra bulk which would have been entailed in the book, and partly because of the recent appearance of a book upon gas-engine design, by Professor Lucke. The descriptive material, however, is complete, and a considerable amount of information which would naturally come under the head of design is here included. The treatment of mean effective pressure, of efficiency, of the guarantee, and a discussion on the producer-gas engine, and on alcohol as a fuel, are new features of this edition. The value of the analysis of the different cycles under which various types of gas engines operate is also increasing, as more attention is paid to these matters by engineers in general.

The illustrations are mainly of the line type (principally wax cuts), but a few half-tones of typical engine installations have been incorporated, some of them in the text, and others on insets. Ten pages at the rear of the book have been devoted to a very complete index, just previous to which are three pages covering a table of hyperbolic logarithms.

Fighting Ships, 1907. Edited by Fred. T. Jane. Size, 12 by 7½ inches. Pages, 500. Numerous illustrations. London, E. C., 1907: Sampson Low, Marston & Company, Ltd. Price, 21s. net.

In many respects the most complete naval publication to be found is the present volume, the compilation of which must have represented a tremendous expenditure of energy. The general scheme is somewhat similar to other annual works of the same sort, in which there are published side by side information regarding the various warships of the several powers, and sketches showing the general distribution of the battery and armor, the masts, funnels and other parts of the ship. This work, however, goes much farther than this, in that it includes also reproductions of photographs from at least one in every type of completed ship, and differentiates in minor points as between ships of the same type or class, so as to enable the different vessels to be readily recognized at sea. The amount of information contained, and especially of detailed information regarding the principal military features of the ships, is extremely great, and, as the work is undergoing continual revision, it is very improbable that any serious errors can have passed through the editor's hands. The various guns and items of armor protection are classified according to arbitrary standards, so that it is quite possible to compare with considerable satisfaction guns of different types in the different navies. In many cases the weight is given of the armor as a whole, while in some cases the weight of battery with ammunition is also given. The comments running through the entire work are especially valuable as indicating points which are not generally known, such, for instance, as the loading positions of the big guns, and the amount of ammunition carried per gun.

In addition to the extremely complete list of ships, with photographs and diagrams, there are silhouettes of most of the important war vessels, as well as some of the principal ocean liners, which might, on occasion, be impressed into service as auxiliary cruisers. These silhouettes are, of course, taken from directly abeam, and in each navy are classified according to the arrangement of funnels and of masts, these being, of course, the most conspicuous features of a ship when seen at a distance.

The second part of the book includes a number of chapters, or essays, devoted to various naval subjects, such as new warship construction, which is a résumé of naval construction within the past few months; programs of new construction; notes upon battery and armor; tables showing the numbers of ships in the principal navies fitted with guns capable of penetrating armor at a distance, and the ships with belts of considerable thickness, and fitted to withstand the attack of heavy projectiles. Warship Engineering includes tables of all warships fitted with turbine engines, and diagrams showing the arrangement in certain special cases. Following this are diagrams of the various principal types of boilers, information on steering gears, coaling at sea, and various auxiliary devices for use in the engine room. The boilers are given some considerable attention, a brief description being given of each of about a dozen different types. The British naval maneuvers of 1906 are treated in some detail, and the work ends with a list and silhouettes of all merchant liners of over 5,000 tons gross belonging to the different merchant fleets of the world, and classified according to nationality and to location where usually found.

In the preface attention is called to the fact that each ship is treated entirely on one page in the book, and that not only the silhouettes and diagrams have been kept thoroughly up to date in connection with changes continually being made in all of the fleets of the world, but also recent photographs of warships have been substituted in very many cases for older ones. In treating of the various battleships of the latest types, it is stated that few if any warships are likely to be built in the future which cannot use all their heavy guns on one broadside. "America in the *South Carolina* led the way in this direction, and the ship of the future is bound to be some improved variation of her.

"In the agitation now proceeding as to the relative superiority of the British fleet, it is somewhat curious that the points tabulated," with regard to the vessels carrying heavy armor-piercing guns, and those carrying waterline belts safe against various guns at more than 4 miles range, "have been little discussed. These tables omit all ships projected in 1907-1908 programs. Such figures would slightly increase the United States superiority in long-range attack. The extremely high figures for the United States ships afford food for considerable thought; for both in ships with high powered guns and in ships impervious to vital injury at long range the United States fleet is superior to any other navy in the world. Even by the inclusion of 40-caliber 12-inch guns of types extinct, so far as new ships are concerned, the United States is an extremely good second, and the corresponding lead in invulnerability outside 7,000 yards is considerably increased." A small table shows that with the 12-inch 45-caliber guns, or the equivalent, the United States and Japan have each twelve ships built and building, while England and France have ten each and Germany six; including the 40-caliber guns Britain leads with forty ships, followed by the United States with thirty-four, France with twenty-seven, Japan with twenty-six and Germany again with six.

Lake Shipyard Methods of Steel Ship Construction. By Robert Curr. Size, 6 by 9 inches. Pages, 172. Figures, 187. Cleveland, Ohio, 1907: The Penton Publishing Company. Price, $2 (8/4).

This is largely a reprint of articles which appeared during 1907 in *The Marine Review*. It is very profusely illustrated, and gives detailed information as to the methods of construction by which such remarkable results have been achieved by the shipbuilders on the Great Lakes. It is devoted largely to a description of the mold system now almost universally in use on the lakes, by means of which the entire vessel is laid out, practically before the assembling of the different parts begins. In particular, the shell plating is all laid off in the mold loft, and the plates, as cut and punched, are so marked as to make identification easy as soon as the construction has proceeded to such a stage as to require any given plate.

The work is in twelve chapters, covering respectively laying off, bulkheads, molds, stern plating, expansion of plating, keel and center keelsons, bow framing and plating, engine foundations, deck houses, masts, the erection of material and the advantages of mold work. Most of the illustrations are sketches showing the methods of joining together the various parts of the structure, as well as the methods of laying them out. A few half-tones are used to illustrate various operations under way, and to show some of the methods by which the work is carried out. The book seems to be a very complete exposition of the methods in use on the lakes, and as such should prove a valuable aid to designers, and to any others interested in this subject.

Annual Report of the (Japanese) Mercantile Marine Bureau for 1906-1907. Size, 7¼ by 10¼ inches. Pages, 135 + v. Tokyo, 1907: Published by the Department of Communications.

This is largely a book of tables covering the shipping and shipbuilding of Japan, with statements showing the total number and tonnage of vessels at the end of 1906, the classification of registered vessels of various types, the shipbuilding establishments and their operations during the year 1906, casualties, life-saving equipment, certificates and licenses, entrances and clearances of shipping at the open ports, lighthouses, encouragement given by the government to shipbuilding

and ship owning, in the shape of subsidies, and various other items of kindred nature.

The merchant marine of Japan, at the end of 1906, is stated to have included 2,103 steamers of 1,041,569 gross tons, and 4,547 sailing vessels of 354,356 gross tons, besides 22,632 junks. The number of vessels entering and leaving the four open ports (Yokohama, Kobe, Nagasaki and Moji) was 57,825, of an aggregate of 83,304,133 gross tons. This includes both ships entering and ships leaving, and includes also the coastwise traffic. Examination of the tables shows that Kobe was the largest port, with 15,220,566 tons entered, and a slightly larger tonnage cleared. Moji stands second, with Yokohama and Nagasaki following. If we omit coastwise traffic, Moji stands first, with 10,311,653 tons entered, and about the same amount cleared; with Kobe second, and the other two ports following.

Navy Year Book. Compiled by Pitman Pulsifer. Size, 5¾ by 9 inches. Pages, 643. Washington, 1907: Government Printing Office.

This book is a compilation of all of the annual naval appropriation laws of the United States from 1883, when the first steel vessels of the so-called "new navy" were authorized, up to, and including, 1907. The first 570 pages of the work are taken up with verbatim reports of these various laws, forming a splendid volume for reference in connection with appropriations for the construction of ships, their armament, armoring and equipment, their maintenance, and all the various items of expenditure of a large sea-going naval establishment.

The next 39 pages of the book are devoted to tables, showing the naval appropriations for the various years; an alphabetical list of all war vessels authorized during the years in question, this list showing the name, type, displacement, speed, draft, contract price of hull and machinery and the date of authorization. The next set of tables lists by years the various ships authorized, and gives the same particulars regarding them as in the preceding table. This shows that during the years in question there have been authorized no less than 170 ships, of a total of 754,762 tons displacement. Next come tables showing the actual total cost of each completed ship of over 2,000 tons displacement, with a statement of the expenditures up to June 30, 1907, on vessels under construction. This table shows that the most costly vessel in the navy at present is the *Connecticut*, with $7,667,607 (£1,575,590). One other, the *Kansas*, is over $7,000,000 ($7,071,143, or £1,453,025), while the armored cruisers are of approximately the same cost per unit as the battleships. The most inexpensive of all the battleships of over 10,000 tons was the *Illinois*, at $4,621,409 (£949,637).

Next come tables showing under the several vessel classifications the number and displacement of warships built and building for Great Britain, United States, France, Germany, Japan, Russia, Italy and Austria, with tables showing the dates, names, displacements, batteries and speeds of all the battleships and armored cruisers built and building for these eight powers. Another table gives the time of building battleships for the United States, the longest period having been 5 years 5 months and 12 days for the *Ohio* of 12,500 tons; and the shortest, 2 years 9 months 13 days for the *Vermont*, of 16,000 tons. The average for the twenty-two vessels completed at the date of the report was 4 years 0 months and 22 days. In each case this comprises the interval between the laying of the keel and the date of first commission.

The French cargo steamer *La Rance*, which we described last September (page 371), and which is fitted with Lentz valve gear and Pielock superheaters, has shown a coal consumption of 0.408 kilogram (0.8995 pound) per horsepower per hour, as compared with 0.511 kilogram (1.127 pounds) for her sister ship *Garonne*, fitted with "ordinary" engine and boilers. *La Rance* developed 1,690 horsepower, as compared with about 1,430 for *Garonne*.

QUERIES AND ANSWERS.

Questions concerning marine engineering will be answered by the Editor in this column. Each communication must bear the name and address of the writer.

Q. 399.—Will producer gas work as well with two-cycle engines as with four-cycle engines? A. L. H.

A.—A two-cycle engine could be designed, in such a manner that the charge of gas and air could be forced into it under a few pounds pressure by a positive blower, that would work to perfection. The objection to the two-cycle engine for use with producer gas applies only to that type which uses crank-case compression. It is probable that the gas, which carries considerable sulphur and carbonic acid, would corrode the brass-work, composition boxes, etc., and affect the oil in the crank case. Besides, with the suction producer, it would have to draw its charge of gas and air under some five or six ounces of vacuum in some cases, which would cut into the power of the engine. I have never tried this two-cycle engine, and these objections may not be as large as they seem. H. W. T.

Q. 400.—With an eccentric sheave 15 inches in diameter and a 5-inch throw, and the engine on dead center, the sheave is moved ⅛ inch on the shaft. How much does it move the valve? The size of shaft is not known. T. M. C.

A.—Assuming that the valve has no lead, the eccentric will be approximately at right angles to the position of the crank, and the virtual position of its center will be practically in a horizontal plane containing the center of the shaft. A movement of the sheave on the shaft of ⅛ inch would produce in the valve a movement of (⅛ inch times the cosine of the angle between a vertical through the center of shaft and the virtual valve rod). As the length of this rod is very great in comparison with the 5-inch throw of the eccentric, the value of this cosine would be almost unity. We may say, then, that the movement of the valve would be only an extremely small fraction less than ⅛ inch.

The size of the shaft has no bearing on the matter, because the eccentric is moved always in such a way that its center traverses a circle the diameter of which is 5 inches, or the throw of the eccentric, and this is the figure which would be used in such a computation. If, as customary, the valve has a lead, the eccentric would not be approximately at right angles with the crank, and the extent of this lead would have to be known before a computation could be made. This would considerably alter the solution, reducing the movement of the valve for a given movement of the sheave.

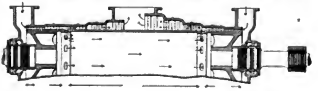
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

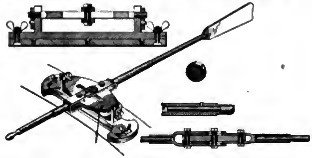
874,356. MARINE TURBINE. EDWIN C. CARNT AND ANDREW FORSTER, EAST COWES, ISLE OF WIGHT, ASSIGNORS OF ONE-THIRD TO J. S. WHITE AND CO., LIMITED, EAST COWES.

Claim 1.—A parallel flow single drum marine turbine oppositely bladed at the steam entry part, thereby constituting a self balance, and bladed at the remaining part in opposition to the propeller thrust, and the whole interior of the drum of which turbine is in communication



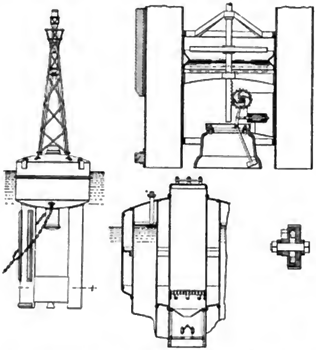
with the outlet ends of the blading of the self balance and the inlet end of the blading of the propeller balance, and constitutes a passage for steam from one to the other. Two claims.

874,817. BOW-FACING OAR. HENRY FLINT, ST. LOUIS, MO.
Claim 1.—A bow-facing oar composed of two sections, a slotted tilting plate, each section pivoted on a line central to the slot, and so



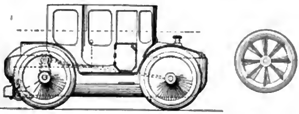
fulcrumed as to move both sections in the same direction, so that a boat can be propelled in the facing direction of the oarsman by a pulling motion. Three claims.

874,646. BUOY. THOMAS L. WILLSON, OTTAWA, CANADA, ASSIGNOR TO UNITED STATES MARINE SIGNAL COMPANY, JERSEY CITY, A CORPORATION OF NEW JERSEY.
Claim 4.—A whistling buoy having a whistle, two air compressor tubes operating the whistle and diametrically opposite each other, and



mooring chains attached fixedly to the buoy and extending in the direction of the plane of the two tubes, so as to hold the edge of such plane to the current. Eight claims.

875,210. CANOE CARRIAGE. JULES J. RAVAILLIER, PARIS, FRANCE.
Abstract.—The invention comprises generally a vehicle body having a lower or base portion in the form of a boat, and supporting wheels provided with tread portions adapted to propel the vehicle upon solid

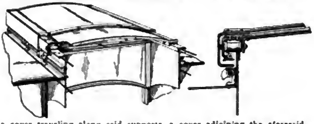


surfaces, and having propelling means for navigating the vehicle in water. The forward wheels are connected with suitable steering apparatus for guiding the vehicle on land, and said wheels are also adapted for guiding the vehicle in water; and suitable motive power is provided in the vehicle for driving said wheels. Six claims.

875,199. CONVEYING APPARATUS. THOMAS S. MILLER, SOUTH ORANGE, N. J.
Claim 2.—In a conveying apparatus, in combination, an outgoing

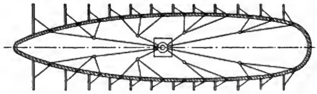
rope, an incoming rope, an engine whereby they are moved inversely, stops on one of said ropes and a load carriage engaging said rope between said stops, and also engaging the other rope. Thirteen claims.

875,734. SHIP'S HATCH. JOHN REID, NEW YORK.
Claim 1.—In a ship's hatch construction, the combination with suitable supports projecting upwardly from the sides of the hatchway, of



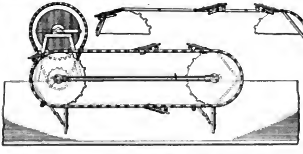
a cover traveling along said supports, a cover adjoining the aforesaid cover and arranged in a higher level, means for raising and supporting the upper cover, and means for causing the lower cover to travel along said supports under the higher cover. Nine claims.

875,752. DEVICE FOR RETARDING AND STOPPING THE MOTION OF SHIPS. EUGENE P. A. VILLETTE, LILLE, FRANCE.
Abstract.—In each side of the ship and according to the height of the same (from the keel to the waterline) are provided spaces to admit iron plates which partake of the form of paddles, though such form may



be varied. The plates are movable and rotatable on hinges secured to the side of the ship. Further, the plates are provided with a maintaining rod, located in the center of the plates for instance, and connected to the driving device located in the ship. Two claims.

876,122. MARINE PROPULSION. ALBERT E. BEEBE, MAYVILLE, N. D.
Claim 2.—A propeller comprising opposite sprocket chains, sprocket wheels receiving the same, cross-bars between the opposite sprocket chains, brace rods between the cross-bars in the direction of length of

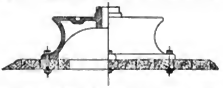


the sprocket chains, paddle blades pivoted to their respective cross-bars, stays made in sections pivoted together, and pivoted at one end to the paddle blades and at their opposite ends to their respective cross-bars, and stops for limiting the closing movement of the paddle blades and mounted on the brace rods. Four claims.

British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

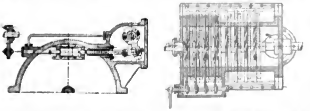
19,106. LIQUID FUEL BURNERS. REGULATING OIL SUPPLY. T. CLARKSON.
A thermostat, of the kind in which two metals having different coefficients of expansion are employed, actuates the valve controlling the supply of liquid fuel to the burners of a steam generator, through the medium of a removable rod having no appreciable expansion. This rod may be interchanged with others of different lengths, so that the temperature at which the thermostat comes into operation may be varied. The thermostatic portion comprises a tube fitting in an outer tube, through which circulates steam from the generator, and a rod supported loosely in the inner tube and of a different expansibility. A removable rod is interposed between the end of the first rod and the valve, and is preferably rounded at its ends.

17,591. CAPSTANS. S. RICHARDS, LOWESTOFT.
Relates to capstans driven from steam engines located on the top of the capstan, and consists in mounting them so as to permit ready access to the steam pipes passing up within the hollow spindle of the capstan.



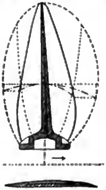
The elevating base is formed in one casting, preferably as a towing post or bollard. The underpart of this base is hollow, and is fixed over an aperture cut in the deck. The upper surface is fashioned as the pan having a central collar and passage for the pipes. Access may also be had to the interior through apertures in the bollard.

17,783. ELASTIC FLUID TURBINES. R. HADDAN, STRAND, LONDON, W. C.
Relates to adjustable valve regulating devices for the stages of multi-stage axial or radial elastic fluid turbines, adapted to allow the ratio of the nozzle openings in successive stages to be varied according to the load. As applied to a parallel-flow turbine with eight stages, the nozzle openings of the first four stages are regulated by slide valves connected by an adjustable device to a shaft, which is operated by hand or by a governor. The slide valves are worked by valve rods, each of



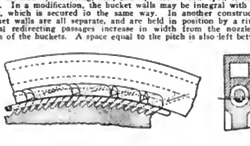
which is connected at one end to a rocking lever, which is fixed by means of an adjustable pin-and-slot device to a disk fixed on the shaft. The rocking levers are adjusted so that the ratio of the nozzle openings is varied according to the load, a light load requiring a high expansion ratio, and a heavy load a low expansion ratio. The slide valves may work on roller bearings either smooth or toothed. The valves may be formed as rocking sectors, with one or more ports, or as rocking cylindrical valves, or as slide valves operated by rocking slotted levers and having one or more ports. The valves are preferably balanced. The details may be otherwise modified.

17,802. SCREW PROPELLERS. G. RABBENO, SPEZIA, ITALY.
The blades are formed of two sheets of metal with an intermediate space, and united at their edges only by being cast solid. The object



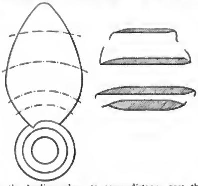
is to render the blades more flexible. In a modification, the laminæ are brazed together. Small propeller blades may be made by flattening a hollow cylinder of metal by pressing it upon a series of molds.

18,145. ELASTIC FLUID TURBINES; IMPACT WHEELS. R. J. HODGES, DEVONSHIRE SQUARE, LONDON.
Relates to the type of impact wheel in which the steam is caused to take a spiral path about the periphery of the rotor. Three methods of forming the buckets are described; a semicircular groove is turned in the periphery of the rotor to enable the buckets to be milled. The groove is afterwards filled by a split ring, which is sprung into place and then secured by soldering, etc., and by wire wound upon it under tension. In a modification, the bucket walls may be integral with the split ring, which is secured in the same way. In another construction the bucket walls are all separate, and are held in position by a ring. The spiral redirecting passages increase in width from the nozzle by the pitch of the buckets. A space equal to the pitch is also left between the



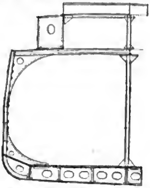
redirecting passages. Several wheels may be arranged in series on the same shaft.

18,012. SCREW PROPELLER. G. QUICK, ROSEHILL, BOURNEMOUTH.
The blades are constructed with their leading edges of double bevel or chisel shape, the angles of each side of the edge being preferably



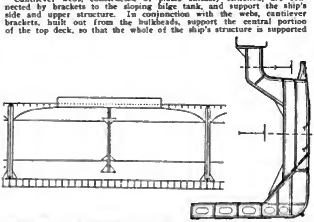
equal. From the leading edges to some distance past the mid-length of the blade, the thickness of the blade is uniform, and then gradually decreases in thickness to the following edge, as shown in the sections. This construction insures that both faces of the blades are of the same pitch, and that the thickness of the blades is uniform at the same radius.

18,833. SHIPS' TANKS; FRAMING. E. H. O. R. ROPNER, STOCKTON-ON-TEES.
Vessels of the trunk type are provided at each side of the trunk with water ballast tanks formed of the side of the trunk, the deck, the lateral extension of the trunk deck, and a wall intermediate of the trunk side and gunwale. The tanks are fitted with web plates spaced through-



out the whole of their length. Web frames support the tanks, and are connected to the double bottom. Portable or fixed pillars may be fitted, but, when dispensed with, diagonal pillars are fitted between the sides of the vessel and the under sides of the tanks. Cross pipes or passages may connect the tanks. The tanks extend the entire length of the cargo holds, stopping at or about the forward and after bulkheads, or they may be fitted for only a part of the length of the vessel, and may be applied to vessels having sloping decks or sloping trunk sides.

18,922. SHIPS' FRAMING; TANKS; DECKS. H. BURRELL, GLASGOW.
Cantilever webs, constructed of plates suitably stiffened, are connected by brackets to the sloping bilge tank, and support the ship's side and upper structure. In conjunction with the webs, cantilever brackets, built out from the bulkheads, support the central portion of the top deck, so that the whole of the ship's structure is supported



without the aid of stanchions or beams in the cargo space. The deck plating is pierced by a series of small openings, to facilitate the passage of grain into the hold below. When the sloping corner tanks are used in conjunction with ordinary floors, the floor plate is connected to the lower boundary plate by lugs, and the lowest strake of the tank plating is extended beyond this boundary plate so as to cover the end of the floor.

International Marine Engineering

MAY, 1908.

ELONGATION AND REBUILDING OF THE ROYAL DANISH STEAM YACHT DANNEBROG.

BY AXEL HOLM.

In November, 1906, the Danish Parliament voted the sum of Kroner 435,000 ($116,600 or £24,000) for the elongation and rebuilding of the royal steam yacht *Dannebrog** for King Frederik VII., and on November 19 the yacht was hauled on the slip of the navy yard at Copenhagen, and work commenced. elongation, and time has shown that this was not so bad after all. The yacht, as it now appears, finished, is a very nice little steamer, and the interior, most of which is worked out after the plans of architect Carl Brummer by the furnishing company (Otto Meyer, of Copenhagen), is as luxurious, tasteful and comfortable as it can be on board a ship of this small size.

A CORNER OF THE DRAWING ROOM ON THE REMODELED DANISH ROYAL YACHT DANNEBROG.

The yacht was a comparatively old flush-decked paddle steamer, built in 1880 by the Burmeister & Wain's shipbuilding company, at Copenhagen; and as it was built of iron, there were professional objections, to the effect that it was not an economical use of the money to rebuild the ship, and not the work for a navy yard. It was said that it would be better to get an entirely new and modern yacht for the use of the king. But the parliament cut the matter short and sanctioned the

Before and after the elongation, the *Dannebrog* was of the following dimensions:

	Before.	After.
Length between perpendiculars	192'	227'
Breadth molded	26' 2"	26' 2"
Breadth over guards	51'	51'
Depth molded	15' 6"	15' 6"
Draft	10'	9' 10"

* The name of the Danish flag.

THE DANNEBROG, BEFORE RECONSTRUCTION, ANCHORED BEFORE RHEDEN.

	Before.	After.
Displacement	890 tons	1,063 tons
Block coefficient of fineness	0.625	0.7
Ratio, length to breadth	7.35	8.7
Ratio, length to depth	12.4	14.6
Gross register tonnage	740	852.7

The contract price in 1880 was about Kroner 700,000 ($187,-500, or £38,500), but this sum certainly was surpassed.

The engines were two compound oscillating sets, working independently of each other on two cranks. Each set consisted of a high-pressure cylinder 30 inches diameter, and a low-pressure cylinder 60 inches diameter surrounding the high pressure, with three piston rods, one for the high-pressure piston in the center, and two for the low-pressure on each side, connected at top by a cross-piece holding the crank-pin bearing. Steam was furnished by two common cylindrical marine boilers, 10 feet 3 inches diameter and 14 feet 2 inches length, besides one small donkey boiler.

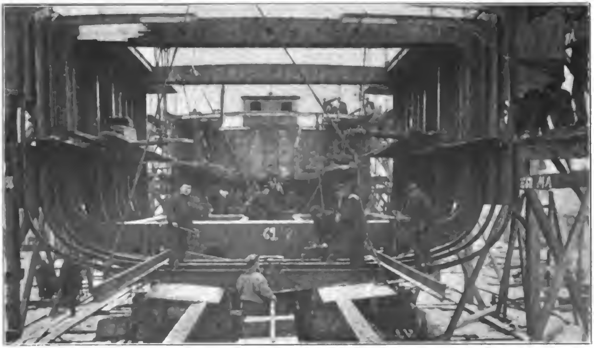
As seen from the drawings, the elongation—35 feet—was provided at two places, one cut forward and the other aft of the wheel boxes, thus adding 17 feet to the space for the royal

THE STATE DINING-ROOM ON THE ROYAL YACHT DANNEBROG.

THIS VIEW SHOWS THE CENTRAL PADDLE-WHEEL SECTION, THE AFTER SECTION, AND THE TWO GAPS TO BE FILLED IN.

family, 4 feet to the engine space, and 14 feet to the suites' rooms. The wheel boxes and the houses on guards were not enlarged, but, as shown, the interior was partially altered, while the large deck houses fore and aft were greatly enlarged and refurnished. Two new boilers were fitted, the dimensions being: length, 10 feet; diameter, 15 feet 6 inches; heating surface, 2,100 square feet; grate area, 62 square feet, and working pressure 75 pounds per square inch, with domes 5 feet high by 3 feet 6 inches diameter. The boilers work without forced draft. The old donkey boiler is still used. The old engines, with only small improvements, were again installed, as also the feathering paddle wheels, but the old wooden floats are substituted by iron ones 8 feet 6 inches by 2 feet 6 inches, twelve in number. The shaft diameter is 10¼ inches, and the wheels are 20 feet in diameter. The four coal bunkers contain a total of 108 tons. The fresh-water supply amounts to 4,900 gallons in three tanks, forward, amidships and aft. To the electrical plant, formerly consisting of an engine and dynamo of 115 amperes capacity, is added one of 80 amperes, the ship being now electrically lighted throughout. A powerful searchlight is installed, and the top and side lights are arranged for electricity. The entire plant was installed by the navy yard, as also the new wireless telegraph outfit.

Besides the alterations mentioned, none were undertaken except in the staterooms for the royal family, the suites and offices, all of which accommodations were renewed throughout. The late King Christian IX. was a plain and homely man, and he would not allow any expenditure on modernizing his yacht. "She is good enough for me," he said, and thus the accommodation, 26 years old, was more than antiquated and fully unfitted for use. As a matter of comparison, the only part of the accommodation aft still in use is the after end of



VIEW FROM THE FORWARD PORTION, SHOWING THE CENTRAL AND AFTER PORTIONS AND THE TWO GAPS TO BE FILLED IN.

the former saloon for the king, now serving as a room for maid servants.

Beginning with the bridge deck, we here find a little steam steering engine in front, and then, between the two funnels, are arranged a chart house and two glass-sheltered lounges or smoke rooms, with a flying bridge on top, and the teak engine skylight between. Aft are two comfortable, curved staircases down to the main deck, for the use of the royal family, and two others for the crew, forward. On this deck is also placed an apparatus for indicating revolutions of the engine, consisting of a complete model paddle wheel in a glass box, electrically connected with the shaft. No awning is carried over this deck, but the steering station in front is fitted in the usual manner with weather cloth and curtains of awning.

The main deck is laid in yellow pine with cemented gutter, and the bulwark plating, with teak rail, is paneled with wood

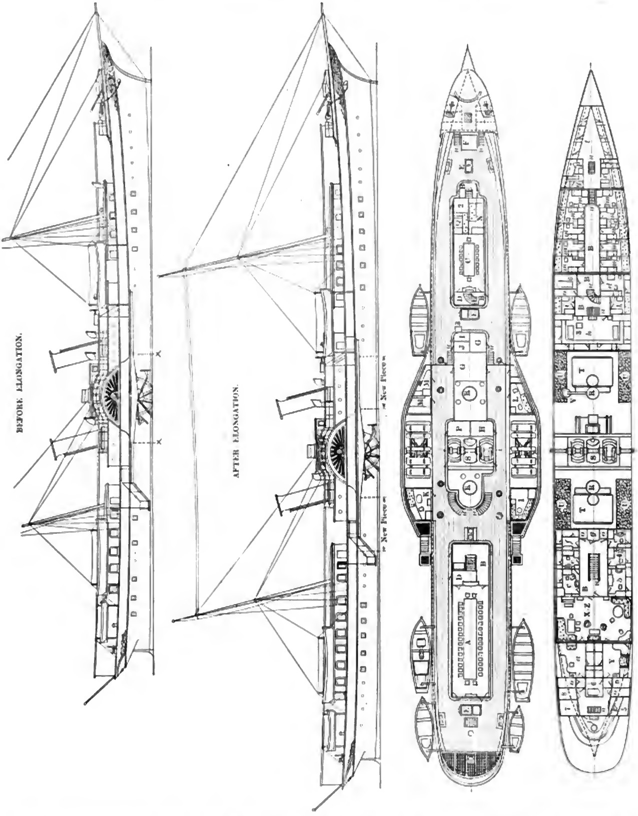
THE MAIN ENTRANCE HALL ON THE DANNEBROG.

all around inside. Forward, under the raised forecastle deck, on which are placed the two bowers with anchor crane and berths, are toilets and rooms for paints, oil, lamps and stores, besides a trunked skylight down to the crew's quarters. Just abaft the forecastle is a windlass of recent date, and companionway for the crew. The steel deck house then following measures 36 feet by 10 feet 6 inches, with the entrance and staircase down to the suites in front. This contains rooms for wireless telegraphy, first lieutenant and chief engineer, a roomy and tastefully fitted mess for officers, seating sixteen persons, separate entrance and staircase for a prince, and, finally, a pantry for officers. Aft of this house is a companionway for officials and servants, and a trunked ladder down to firemen's quarters. Then in the fore end of engine and boiler casing are arranged spaces for wine and china, a galley for crew, and a large, well-fitted galley for the court. Over the engine are placed the silver room, and stateroom for second engineer.

Iron-front bulkheads, with iron doors, are placed from the houses on the guards to the boiler casing, and over the coal bunkers are placed circular coal scuttles level with the deck, eight in number. On starboard guard, forward, is a toilet for officers, next the apartment for the ship's captain, and aft a large smoke-room for the king. This cozy room is carried out in pure white, the carved paneling being in dull white and the ceiling enameled; the furniture in dark mahogany with buff upholstery, and the dark brown carpets, form an agreeable contrast to the white walls and ceiling. In port guard are, forward of the wheel box, two rooms for the large galley, and, aft, an apartment for the king's flag captain. Aft of these houses are on both sides arranged the gangways and accommodation ladders.

The iron deck house aft measures 52 feet by 11 feet. On the front end of this is a teak skylight, with seats over the trunk hatch down to after hold, and inside are, first, the entrance and stairways down to the royal apartments. The entrance is an exceedingly tasteful space, as may be seen from the photograph, the paneling and pilasters being in elm wood, and the ceiling dull white. Over the staircase is placed a little skylight, and on the port side is a cozy sofa upholstered in yellow; the carpet is also yellow. From this entrance a glass door leads to the king's dining-room, this being particularly large, 37 feet by 11 feet, capable of seating thirty-four persons. It is fitted out in a very extraordinary manner. The paneling and ceiling are laid all over with silver, covered on the walls with a transparent blue color, the molds and the large square windows being framed by broad golden lists. The furniture in dark red mahogany, the red leather upholstery, the carmine red curtains and Smyrna carpet, form a bizarre and curious impression of great effectiveness. At the after end is a small sideboard over the radiator, and at the forward a larger buffet, with bronze lattice work in front; the latter is surmounted by an artistic relief in white and blue china. The hemispherical chandeliers, six in number, in the middle line, are artistically worked out with glass prisms in gilt metal. Two doors at the after end lead to the open, and between the saloon and the entrance is situated a roomy pantry. Aft of the house is a companionway for maids and servants, a skylight and a hand-driven capstan. Over the quadrant and tiller is a large wooden grating, and over the rudder head is mounted a spare steering gear. The six boats hang, as shown, outboard in davits all around the ship, the outfit consisting of one 25-foot steam launch, one pinnace of 28 feet and two of 25 feet, one 21-foot life boat and one 15-foot dinghy.

Under the main deck the hull is divided into seven watertight compartments by six bulkheads, of which two are new. Forward, between the first and second bulkheads on lower deck, are berthed crew and petty officers, the space being 28 feet in length, and beneath this deck are also arranged spare berths for crew. Then on the lower deck are located, in the next watertight compartment, ten large staterooms for the gentlemen of the court. The rooms are carried out all in the same manner, completely in dull white, the upholstery, carpets and curtains varying in colors with each room; the light ports are large and square, while steel coverings with circular glass are hinged outside. This compartment occupies 28 feet 6 inches in length, and the next 26 feet. Here is first arranged a separate accommodation for a prince, consisting of a sleeping room, bath, toilet and entrance with staircase to main deck. The sleeping room is carried out in the same tasteful manner as before mentioned for the suite. Then follow rooms for the king's cook, the quartermaster-sergeant, and, close to forward engine bulkhead, the servants' quarters. Under lower deck in this compartment are berthed the firemen, with passage to main deck by means of the trunked ladder, and to the engine room through a watertight door. The engines and boilers then take up 60 feet of the length. The living rooms



THE DANISH ROYAL YACHT DANNEBROG AFTER ALTERATION, SHOWING AT X X THE POSITIONS OF SEVERING ORIGINAL HULL.

A, Royal dining saloon. B, Entrances. C, Officers' messroom. E, Stairways, down. F, Windlass. G, Galley. H, Silver room. I, China closet. J, Wines. K, Flag captain. L, Ship's captain. M, Scullery. N, Officers. O, Toilet. P, Assistant engineer. Q, First engineer. R, Funnel and uptakes. S, Propelling engine. T, Main boilers. U, Coal bunkers. V, Donkey boiler. X, King's saloon. Y, King's sleeping room. Z, Queen's saloon. a, Queen's sleeping room. b, Crown prince. c, Crown princess. d, Prince. e, Ladies in attendance. f, Maid servants. g, Trunked hatch. h, Servants. i, Cook. k, Quartermaster-sergeant. l, Saloon. m, Gentlemen of the court. n, Wardrobe. p, Gunner. q, Carpenter. r, Petty officers. s, Boatswain. t, Crew. u, Stairways, up. 1, Smoking room. 2, Wireless telegraph. 3, Trunked ladder for firemen. 4, Princess. 5, Valet. 6, Bath rooms. 7, Queen's wardrobe. 8, King's wardrobe.

for the royal family occupy the remaining two compartments aft, measuring 38 and 44 feet, respectively.

Here is first the roomy entrance hall, in white all over, with the staircase to main deck, and doors opening to the royal saloon, to the staterooms for the crown prince and crown princess, to a room for a princess, two rooms for ladies in attendance, a room for two maid servants, as also to two toilets, and the trunk to space below. These staterooms are all carried out in the same manner as mentioned above for the suites and the prince forward. In the rooms for the crown prince and crown princess are small bath tubs arranged in the floor, covered with trap doors and the carpets, when not in use.

The royal saloon is a very attractive room. The walls are painted dull white, and the ceiling white enameled, the paneling and molds being covered with carved reliefs and lists. Opposite the swinging doors from the entrance hall is placed a great allegorical picture in a carved white frame, between the doors leading to the king's and queen's sleeping rooms, and on both sides of the swing doors are situated the steam radiators covered by small sideboards with marble tops, and mirrors over. The furniture is carried out in polished lemon wood, with upholstery in yellow damask.

In two corners, as shown, are arranged large sofas, tables and chairs. In another corner is a writing desk; a piano is also placed in this room, and under the large painting mentioned are a sofa, with table and arm chairs. The soft and delicate Smyrna carpet is yellow, and so are also the silk curtains for the square side lights. The illumination consists of three chandeliers as in the dining saloon, and several artistic metal standing lamps. As shown in photograph, the whole impression of this room is very agreeable, light and comfortable.

The doors from this saloon to the royal sleeping rooms lead through the after watertight bulkhead, and, hidden in the paneling, are here arranged two horizontal sliding watertight doors worked automatically from the main deck. These two sleeping rooms, being carried out both in polished elm, are almost identical, but the placing of the furniture, carpets and curtains, and color of upholstery, are varied. In the king's room the upholstery is in striped olive green silk, and in the queen's room in white and light blue, the color of carpets and silk curtains corresponding. The ceiling is white enameled, and the side lights are square. Over the king's berth is placed an old compass, arranged in a metal crown. It was given a long time ago to the late King Christian IX., by a fisherman.

Just abaft these rooms are situated a toilet on each side and a roomy bath amidships, and on the port side two large wardrobes for the royal use; another toilet for servants, a room for the king's valet, and finally the above-mentioned room for the queen's maid servants, in the end of the former royal saloon.

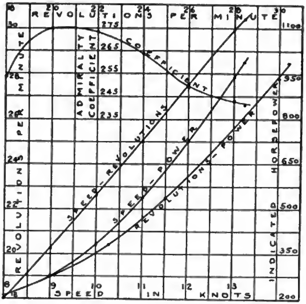
The heating is by steam throughout, and in every watertight compartment is placed an electric fan, taking the heavy air at the floor, the new air coming in at the ceiling through downcast ventilators. The spaces below lower deck, where not otherwise mentioned, are used for stores, provisions, wines and water tanks; while a mess room for petty officers and officials is arranged forward.

The two old schooner masts are again used, but, while formerly carried through the deck houses to main deck, they are now placed in sockets on the tops of the houses. Awnings are carried all fore and aft over main deck. The hull is black painted, with gilt carved ornamentals fore and aft, as also on the wheel boxes, the deck erections being white throughout. The whole appearance of the little craft is very handsome, and as it is intended for navigation only on the closed waters among the Danish "hundred islands," it is well fitted for its purposes.

Finally we have the results of the 4-hour trial trip in August, 1907, and the indicated horsepower for varying speeds, viz:

Draft forward	9 feet 6 inches
Draft aft (mean 9 feet 10½ inches)	10 feet 3 inches
Displacement	1,063 tons
Speed in knots	13.04
Admiralty coefficient	246.
Revolutions per minute	30.0
Slip in percent	22.08
Boiler pressure, pounds per square inch	75.5
Vacuum in inches	24
Total indicated horsepower	937
Coal consumption per hour	2,380 pounds
Water consumption per hour	20,300 "
Coal consumption per horsepower-hour	2.55 "
Water consumption per unit	21.7 "
Evaporation of water per pound of coal	8.53 "

Speeds.	Revolutions.	I. H. P.	Admiralty Coefficient.
8	18.0	210	254
9	20.25	276	275
10	22.6	380	274
11	25.0	536	264
12	27.5	725	248
13	30.0	937	244
13.2	30.4	990	242



PROGRESSIVE CURVES OF PERFORMANCE OF THE DANNEBROG.

The curves show graphically the result of these progressive trials, the performance, as indicated by the admiralty coefficient, being very good. The fuel endurance, based on the 4-hour run, appears to be about 1,300 nautical miles at a speed of 13.04 knots. The most economical speed is from 9 to 9½ knots. The index, according to which the power varies, as compared with the speed, is only 2.32 from 8 to 9 knots, becoming 3.47 between 11 and 12 knots, and 3.2 between 12 and 13 knots.

Notice.—On page 127 of our March number there was published by inadvertence an article which now appears to have been copyrighted and published by *Engineering* (London), Oct. 4, 1907. This was furnished us as an original article covering the Crocco-Ricaldoni hydroplane, and was accepted in good faith. We regret that its publication has put us in a bad light, and extend herewith our acknowledgments to *Engineering*.

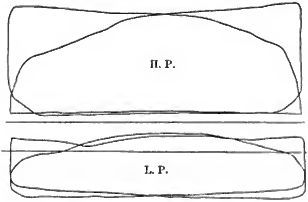
Trials of Lightship Number 88.

In September and October of 1907 we published an extensive description of five light vessels built for the United States Government by the Harlan & Hollingsworth Corporation, Wilmington, Del. The lighthouse board has been good enough to furnish us with details of the trials of one of these five vessels.

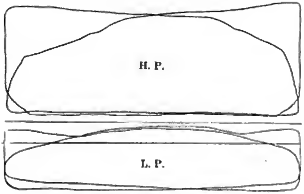
The ship has a length over all of 135 feet 9 inches, a length on the waterline of 112 feet 11 inches, a molded beam of 27 feet and a mean draft on trial of 12 feet 1 inch. The trial took place in the Delaware River Nov. 22, 1907, and the displacement (fresh water) was 576 tons. The block coefficient was 0.572, and the wetted surface 4,749 square feet.

There is one compound engine, driving a solid four-bladed propeller. The engine has cylinders 16 and 31 inches in diameter, with a stroke of 24 inches, cutting off in the high-pressure at 66 percent. The diameter of piston rod is 3½ inches. The cooling area of the surface condenser is 1,160 square feet. The propeller has a diameter of 7 feet 9 inches, a pitch of 10 feet and a pitch ratio of 1.29. The developed area is 2,328 square inches, and the projected area 1,840 square inches. The ratio of projected to disk area is 0.271.

Steam is furnished by two boilers exhausting into a single stack 4 feet in diameter and 45 feet high above the grate.



SAMPLE INDICATOR CARDS FROM STANDARDIZATION RUNS.

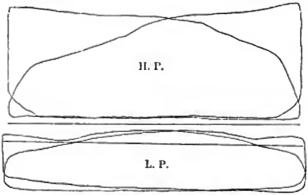


CARDS FROM 6-HOUR FULL POWER TRIAL.

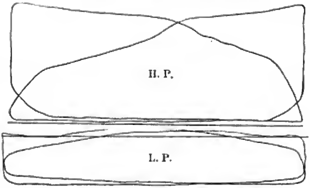
These boilers are of the gunboat type, working under natural draft, and have a diameter of 9 feet 3 inches and a length of 16 feet 3⅛ inches. The working pressure is 100 pounds per square inch. The total heating surface is 2,874 square feet, with a grate area of 73.2 square feet, giving a ratio of 39.26 to 1.

Two sets of runs were made, one set being over the measured mile (5,280 feet), while the other was a 6-hour continuous trial at full power. The measured mile trials consisted of three runs in each direction, in order to determine the revolutions required for a speed of 10 knots. The mean of all the runs showed a speed of 9.98 knots with 125.7 revolutions per minute, and a slip of 19.2 percent. During the 6-hour trial the maximum horsepower observed was 394, the mean having been 320 horsepower, 119.9 revolutions per minute and a vacuum of 26.66 inches. The mean steam pressure in the boilers was 98.6 pounds per square inch.

Four sets of cards are shown, one set being taken during



LINKED-UP CARDS—HIGH-PRESSURE CUT OFF, FIVE-EIGHTHS.



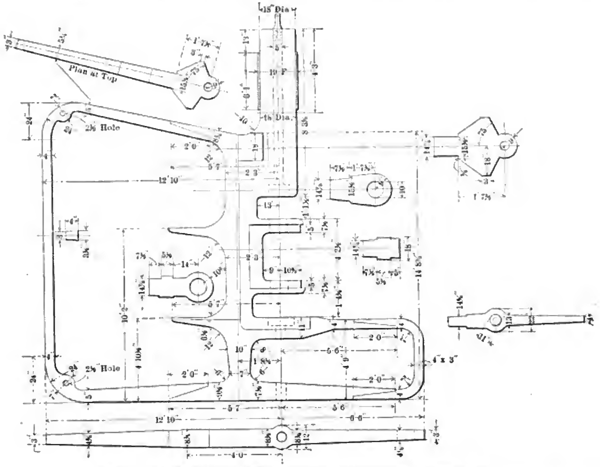
LINKED-UP CARDS—HIGH-PRESSURE CUT OFF, ONE-HALF.

Standardization Run.	High-Pressure. Top.		Bottom.		Low-Pressure. Top.		Bottom.
R. P. M.	....	....	....	126	....	....	....
Vacuum	....	....	....	26.5	....	....	....
I. H. P.	....	....	....	260	....	....	....
I. H. P.	....	206	....	....	....	154	....
Steam pressure	....	97	....	....	....	*6.25	....
Mean effective pressure	71.24	....	66.28	....	13.29	....	12.68
Mean reduced pressure	....	....	....	31.42	....	....	....
Six-Hour Trial.	**High-Pressure. Top.**		**Bottom.**		**Low Pressure. Top.**		**Bottom.**
R. P. M.	....	....	....	126.5	....	....	....
Vacuum	....	....	....	26.7	....	....	....
I. H. P.	....	....	....	359	....	....	....
I. H. P.	....	204	....	....	....	155	....
Steam pressure	....	96	....	....	....	*6.25	....
Mean effective pressure	69.42	....	66.11	....	13.67	....	13.36
Mean reduced pressure	....	....	....	31.21	....	....	....
Linked Up ⅝.							
R. P. M.	....	....	....	122.5	....	....	....
Vacuum	....	....	....	26.8	....	....	....
I. H. P.	....	....	....	329	....	....	....
I. H. P.	....	193	....	....	....	136	....
Steam pressure	....	96	....	....	....	*4	....
Mean effective pressure	68.12	....	64.3	....	12.62	....	11.89
Mean reduced pressure	....	....	....	29.56	....	....	....
Linked-Up ½.							
R. P. M.	....	....	....	118	....	....	....
Vacuum	....	....	....	26.8	....	....	....
I. H. P.	....	....	....	298	....	....	....
I. H. P.	....	175	....	....	....	123	....
Steam pressure	....	97	....	....	....	*2	....
Mean effective pressure	62.28	....	59.5	....	11.51	....	11.12
Mean reduced pressure	....	....	....	27.77	....	....	....

* Receiver pressure.

the standardization run, one during the 6-hour trial, and two sets of linked-up cards on cut-offs of ⅝ and ½, respectively. The results corresponding with these various cards are shown in the table.

Observations of the auxiliary machinery showed a mean revolution per minute for the circulating pump of 196; for the air pump, 33; for the feed pump, 18.6. The temperature on deck was 55 degrees F., with the following observed temperatures below: Engine room, 80; injection water, 41.9; outboard discharge, 86.6; hot well, 102.6; feed heater, 158 degrees. The indicator springs used were in all cases 60 pounds per inch for high pressure and 20 pounds for low pressure.



DETAILS OF THE WROUGHT-IRON RUDDER FRAME OF THE UNITED STATES BATTLESHIP OHIO.

A FEW CONSTRUCTIVE DETAILS.

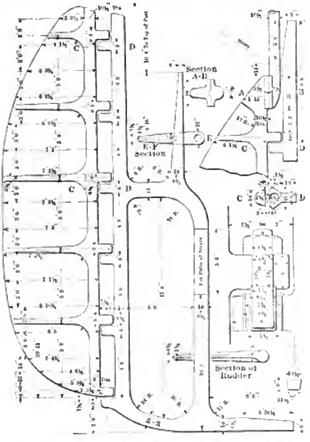
Through the courtesy of a correspondent, we are enabled to present a number of details of rudders, rudder frames, spectacle frames and propeller struts, steering-gear details, stern posts and counters, ram stems, bilge keels and hawse pipes. These cover Pacific coast practice in both warships and mercantile vessels, and are thoroughly up to date, most of the designs having been made within the last seven or eight years.

RUDDERS AND FRAMES.

Four examples are given, they being, respectively, from the American-Hawaiian Steamship Company's steamers *Mexican* and *Columbian*, the United States cruiser *Milwaukee*, the armored cruiser *California* and the first-class battleship *Ohio*. The warship rudders are all balanced and are of similar form. Reference to the drawings will show how radically the steamship rudder differs from the others. In general, the dimensions are shown on the drawings, but some features not so shown may be given here.

The rudder frame of the battleship *Ohio* is made of wrought iron, and weighs 29,860 pounds. The total weight of the rudder, including filling, is 43,448 pounds. The different items outside of the frame include the top plate, 1,370 pounds; center plate, 2,015 pounds, and bottom plate, 2,805 pounds. The pintles, with composition sleeves, account for 1,444 pounds; the Oregon pine filling for 3,859 pounds; the angle and plate stiffeners inside the rudder for 718 and 596 pounds, respectively; while smaller items make up the total. This rudder has a maximum height of 15 feet 11⅝ inches and a total fore and aft length of 19 feet 4 inches, of which 12 feet 10 inches covers the portion aft of the axis. The rudder stock has a diameter of 18 inches, and is fitted with a brass sleeve 19 inches in external diameter. The total height of the rudder, including stock, is 19 feet 11⅛ inches.

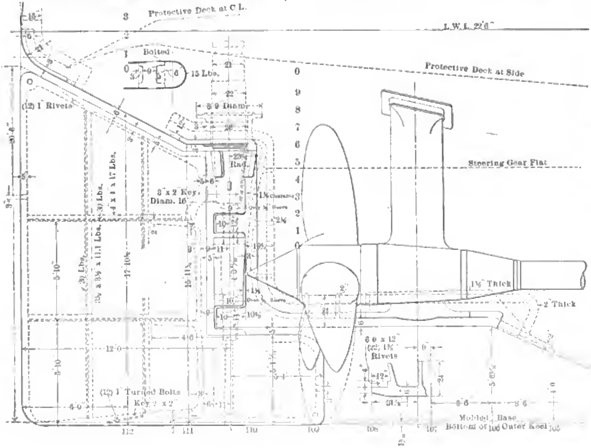
The rudder of the *Mexican* is of cast steel, with a rudder stock of wrought steel, the latter weighing 6,166 pounds. The stern frame is of wrought iron, with a weight of 33,900 pounds. The rudder stock has a diameter of 10½ inches, and is fastened to the rudder by means of a palm, 24 inches wide and 30 inches deep. Connection is made by means of eight turned bolts, 2¾ inches in diameter and located on two vertical lines 17½ inches apart. The backbone of the rudder has a diameter at the head of 10½ inches and at the foot of 8 inches. The rudder pintles have a net diameter of 5¼ inches and a diameter over bushing of 6⅛ inches. The total height of this rudder to top of palm is 32 feet 5 inches; the length of the stock is 18 feet 3 inches.



STERN FRAME AND RUDDER OF STEAMSHIP MEXICAN.

The rudder of the *Milwaukee* consists of a stock of forged steel weighing 10,179 pounds; a rudder frame in two pieces, of which the forward part weighs 26,640 pounds, and the after part, 2,450 pounds; stiffening and side plates and angles aggregating 9,040 pounds; filling of Oregon pine and a composition of one-half tar and one-half pitch, amounting to 6,167 pounds, and other items making up a total of 56,591 pounds. The stern post weighs 30,200 pounds, and is of cast steel. The cast-steel counter-casting accounts for 1,900 pounds, and the watertight gland for 1,226 pounds. The maximum height of the rudder is 20 feet, the total length being 17 feet 4 inches, 5 feet 4 inches of which is forward of the axis. The rudder stock has a diameter of 21 inches, and is fitted with a sleeve of an outside diameter of 22 inches. The inner diameter of the watertight gland is 26 inches. The outside plates are of 15-pound steel. The total area of the rudder is 235.74 square feet, of which 208.96 square feet, or 88.7 percent, is aft of the axis. The center of gravity is 5.29 feet aft of the axis, and 8.08 feet above the bottom.

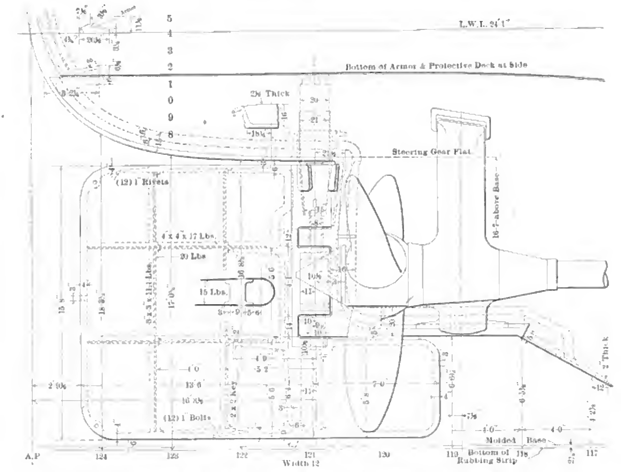
The rudder of the *California* differs from those of the other two warships mentioned in that the top line is horizontal, instead of following the shape of the bottom of the ship aft of the rudder axis. This rudder has an area of 249 square feet and a total weight of 53,022 pounds. The stern post weighs 26,580 pounds, being of cast steel, while the counter-casting weighs 9,000 pounds. The total weight of the rudder includes two frame castings, of which the forward one weighs 24,553 pounds and the after one 1,875 pounds. The stock weighs 8,037 pounds; the side plating, 7,005 pounds; the plate and angle stiffeners, 2,008 pounds; the filling of Oregon pine, with a composition consisting half of tar and half of pitch, weighs 6,630 pounds; smaller items make up the total. Of the total area of this rudder, 209.82 square feet, or 84.3 percent, is aft of the axis. The center of gravity of the rudder is 5.14 feet aft of the axis, and 7.04 feet above the lower edge. The total



STERN POST, RUDDER AND COUNTER CASTING OF THE SEMI-ARMORED CRUISER MILWAUKEE.

height of the rudder is 15 feet 8 inches, while the bottom is located 6 inches above the molded base line of the ship. The extreme length of the rudder is 20 feet 6 inches, of which 7 feet is forward of the axis. The after side of the rudder, which is vertical, is 2 feet 9½ inches forward of the after end of the waterline of the ship, whereas in the case of the *Milwaukee*, the rear edge of the rudder is in line with the after end of the waterline. The side plating of the *California's* rudder is 15 pounds per square foot.

(*To be Continued.*)



THE STERN POST, RUDDER AND COUNTER CASTING OF THE ARMORED CRUISER CALIFORNIA.

The German Ore Steamer Narvik.

BY E. OMMELANCE.

This ship is the first turret-deck steamer built in Germany on the principle so largely developed by William Doxford & Sons, Sunderland. It has been in service since the end of 1905, and during this time has shown that the construction and design were well carried out. The keel of the *Narvik* was laid in August, 1904, at the Krupp Germania-Werft, Kiel; the ship was launched April 29, 1905, and made her first trial trip under ballast on Aug. 2, 1905. The contract speed of 11.5 knots was reached on the measured mile, in spite of heavy weather, with a mean of 1,750 horsepower.

The ship is a single-screw steamer, built according to the requirements of the German Lloyds to class 100 A L (E), and is built of steel. She has a capacity of about 6,000 tons of cargo, and, with full bunkers and complete outfit, has a draft of 6.86 meters (22 feet 6 inches). This corresponds with a displacement of 8,622 cubic meters, or 8,380 tons. The main dimensions are as follows:

	Meters.	Feet.
Length between perpendiculars	104.32	342.
Greatest molded breadth	14.17	46.5
Depth to main deck	8.42	27.6
Height of turret deck	1.9	6.2
Breadth of turret deck	7.8	25.6
Area of immersed midship section	94.38	1,017,
Area of loadwater plane	1,307.8	14,080.

The bunkers hold 500 tons, and the ship can be coaled from either the turret deck or the shelter deck. On the latter is a hatch forward of the engine casing, in which a chute has been built, in order to fill the lower bunkers directly. From the turret deck the coal can be delivered into this chute through hinged doors. Besides this, coaling scuttles have been provided on the deck outside the turret proper. The second hold may be put in connection with the fire room by means of a vertical watertight sliding door, so that it can serve as a reserve bunker. The ship can carry a total of 2,300 tons of water ballast, of which 1,600 tons are in the double bottom. The net and gross register tonnages are respectively 3,575 and 2,299.

In designing the separate portions of the structure, the ship follows the normal requirements of the German Lloyds, but in some particulars deviates from them. These are especially in the greater height of the double bottom, and in the provision of the turret deck, which calls for particular consideration. The thickness of the inner bottom was regulated with due regard to the great weight of a carload of ore, which it was required could be dumped in bulk into the hold. On that

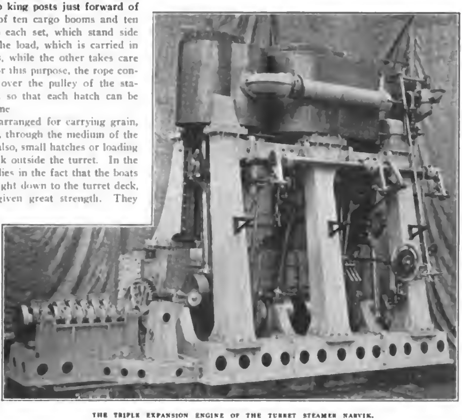
THE TURRET STEAMER NARVIK ALONGSIDE PIER, IN COURSE OF LOADING BULK CARGO.

account the double bottom is divided into square compartments on the longitudinal system. Under the hatches the double bottom, which is covered with pitch-pine planks, 65 millimeters (2½ inches) thick, is strengthened by a doubling of fir. In order not to limit too much the size of hold, the stanchions under the hold beams are placed only at the ends of the hatches, and are made correspondingly stronger. The outer skin is joggled, and, in order to save weight, the angle bars are replaced as much as possible by flanges.

In the design of the ship, the principle object in view was to give the greatest possible celerity to the operations of loading and unloading. For each of the four holds there are two cargo booms and two winches. In addition to this, the largest hold has, for the purpose of loading and unloading as quickly as the others, an additional two cargo booms and two winches, the former being mounted on two king posts just forward of the bridge. This makes a total of ten cargo booms and ten winches. Of the two winches in each set, which stand side by side, one is used for raising the load, which is carried in buckets supported by three chains, while the other takes care of the swinging of the booms. For this purpose, the rope controlling this swinging is carried over the pulley of the stationary boom; for it is arranged so that each hatch can be emptied from only one side at a time.

In order that the ship may be arranged for carrying grain, the turret tanks may also be used, through the medium of the large hatches. For this purpose, also, small hatches or loading chutes have been fitted on the deck outside the turret. In the outfit of boats, particular interest lies in the fact that the boats above this outer deck may be brought down to the turret deck, and the davits here have been given great strength. They naturally may be swung out much farther from the ship's side than would be the case with davits above.

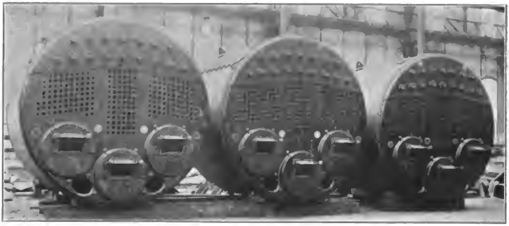
The officers' quarters are separated from the engine-room crew. The first are alongside the captain's quarters forward, in two deckhouses, one above the other, which contain also the saloon, spare room, toilet and bath. The crew and stewards, cook, etc., are also in two structures, one over the other, which are further aft, and in the neighborhood of the engine room. The crew's mess room is in the same structure. The commander's bridge, which reaches over the full breadth of the ship, is protected by a solid substructure against a heavy sea. This serves to cover storerooms, signal lights and companionways. The ship may be steered from either the upper or the lower bridge. A reserve hand-steering device is located on the



THE TRIPLE EXPANSION ENGINE OF THE TURRET STEAMER NARVIK.

poop. The steam-steering outfit is in the turret deck on a platform opening above the engine-room shaft.

The ship is driven by a triple-expansion engine with three cylinders, the diameters of which are respectively 600, 970 and 1,600 millimeters ($23\frac{5}{8}$, $38\frac{1}{4}$ and 63 inches), with a common stroke of 1,150 millimeters ($45\frac{1}{4}$ inches). With a steam pressure of 13 atmospheres (191 pounds gage per square inch), the revolutions are seventy-eight per minute. The three cylindrical return-tube boilers have altogether a heating surface of 550 square meters (5,915 square feet), and a grate surface of 16.5 square meters (177.5 square feet). The ratio is thus 33.3 to 1. Each boiler is single ended and has three corrugated furnaces. The steam used in the auxiliary machinery is exhausted into the main surface condenser.



THREE SINGLE-ENDED BOILERS OF THE GERMAN ORE-CARRYING STEAMER NARVIK.

THE GERMAN TURRET STEAMER NORDSEE STEAMING IN BALLAST, AT LIGHT LOAD LINE.

A LARGE ORE TRANSPORTING STEAMER.

BY DR. ALFRED GRADENWITZ.

The ore transporting steamer *Nordsee*, which was recently built by the Krupp Germania-Werft, Kiel, is the largest turret-deck steamer of the German mercantile fleet in the Baltic. In fact, while being mainly designed as sister ship to the turret-deck steamer *Narvik** (constructed at the same yards) the *Nordsee*, which was built of Siemens-Martin steel as a single-screw steamer for the highest class of German Lloyds under the latter's special survey, surpasses the capacity of the former ship by about 1,750 tons. The following are the main data of the vessel:

	Meters.	Feet.
Length between perpendiculars	112.77	370.
Maximum width, molded	15.85	52
Side depth below main deck	9.09	29.8
Draft	7.32	24
Displacement with loaded bunkers and full equipment		11,110 tons

The *Nordsee* is provided with a continuous double bottom 1.14 meters (45 inches) in height, and, in front of the boiler room, above this double bottom, with a deep tank, 3.65 meters (12 feet) in height. This arrangement was chosen specially with a view to the use of the steamer for the transport of ores, as the centers of gravity of the load, as well as of the ballast, are thus raised, decreasing the excessive initial stability, and thus enabling the ship to perform a more uniform and steady motion in the case of a rough sea. The deep tank will furthermore prove valuable in the case of sailing with ballast, enabling the propeller to be submerged entirely. The bilge keels, 60 meters (197 feet) in length and 30 centimeters (12 inches) in breadth, likewise contribute to improving the behavior of the ship in the case of a rough sea.

The double bottom and deep tank, inclusive of the fore and rear peaks, may contain an aggregate of 3,050 tons of water ballast, which, by the aid of the powerful pumping plant of the steamer, can be emptied within five hours. The vessel is divided into six compartments by five watertight transversal bulkheads. The fore and rear peaks, as above mentioned, are

* See page 200.

used with the double bottom and deep tank for the storing of water ballast. The second, fourth and fifth compartments are used as hold, while the third contains the propelling machinery. The engine and boiler rooms are separated from one another by a bulkhead reaching up to the turret deck. In front of the boiler room has been arranged a transverse bunker of about 600 tons capacity.

The engine and boiler plants have likewise been constructed at the workshops of the Germania shipyards. The main engine is triple-expansion, working on three cranks, with cylinders 600, 980 and 1,620 millimeters (23⅝, 38⅝ and 63¾ inches) in diameter, and 1,150 millimeters (45¼ inches) in stroke, and is provided with all improvements for insuring economical operation. Three cylindrical tubular boilers, with

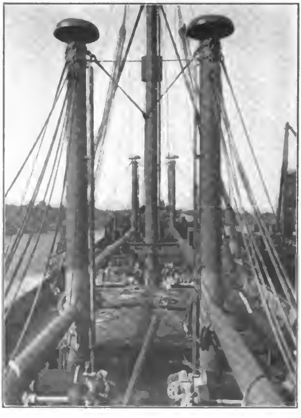
VIEW ON NORDSEE, LOOKING AFT FROM FORECASTLE.

return flues, are used for generating the steam. These have a total heating surface of 480 square meters (5,170 square feet) as measured on the water side, and 12 square meters (129 square feet) grate surface; the ratio being 40 to 1. They are designed for a steam pressure of thirteen atmospheres (191 pounds per square inch), and provided with artificial draft on the Howden system.

In order to allow of a rational utilization of the ship, special attention has been bestowed on making the loading and unloading plants as perfect as possible. The steamer accordingly has six hatches, each of which is 6 meters (19 feet 8 inches) in length by 5.5 meters (18 feet) in width, and two of these are used for each hold compartment. Two steel masts, 33 meters (108 feet) in height, are arranged, one forward and one aft; each of these carries four wooden outriggers (cargo booms). In addition, there are provided forward, four loading poles (king posts) with one outrigger each. These twelve outriggers are operated by twelve steam winches, the

BOW VIEW OF THE NORDSEE.

steam supply for which has been so designed as to allow all of them to work simultaneously. All the outriggers are balanced, the pivot of the outrigger and the point of attachment of the load being situated in the same vertical plane. Means



VIEW ON NORDSEE, LOOKING FORWARD FROM BRIDGE.

have furthermore been provided for allowing the pendants of the outriggers to be automatically slewn, by displacing their points of suspension.

The unloading operation is further accelerated by the loading platforms arranged for hinging, one of which has been installed at each side of each hatch, giving an aggregate of

VIEW ALONG THE OUTER LOWER DECK OF THE NORDSEE.

twelve. They are arranged at such a distance as to allow the wooden hatch covers to be used as well for these platforms. The latter are used for receiving the loading buckets filled with ore, and, on the other hand, for attaching shoots, through which the ore is conveyed directly into the lighter ships placed alongside. The substantial hauling winch, intended for maneuvring the vessel and lighters, in no small degree contributes to further improving the efficiency of the loading and unloading plants.

By the aid of these means, the whole of the load (7,600 tons) can be discharged within 36 hours at most, while, according to the experience gained in connection with the sister ship *Narvik*, the time limit will be most likely reduced by some hours. The loading from railway trucks on the quay takes only about 10 hours. As a whole wagon load (carload) of ore is dumped at once from a considerable height into the hold, the double bottom has been protected by substantial double planking within the range of the loading hatches.

The accommodation provided for the staff and crew is exceedingly spacious, and of remarkably tasteful design. The whole of the fittings, including the elegantly designed furniture of the drawing room, and the specially well upholstered captain's rooms, have likewise been constructed at the shipyard.

The machinery and deck staffs are strictly separated from one another, each of the two categories having a mess designed for twelve men, which, like the remaining rooms of the ship, have been provided with electric lighting. The cabins are arranged most conveniently, the captain being enabled from his berth to watch anything that may occur on the navigating bridge, while the machinists' quarters give direct access to the engine room. The bridge, extending throughout the breadth of the ship, is protected against breakers by an entirely inclosed sub-structure, containing the stairs, as well as the rooms for storing the signaling lanterns.

While being mainly intended for the transport of ore between the Norwegian harbor of Narvik and Rotterdam, the installations of the ship will enable her to be used as well for the transport of other goods in bulk, such as coal, corn, etc.

In connection with her first journey, made a short time ago, the steamer far exceeded any expectations warranted by the excellent results of the trial runs. In fact, the contract called for a speed, with about 7,600 tons load, inclusive of the bunker coal, of 10 knots. Instead of this, with a surplus load of 356 tons (a total load of 7,956 tons) a speed of 11.46 knots was reached downstream, and 10.21 knots upstream, giving an average of 10.83 knots. This surplus of capacity and speed constitutes a remarkably satisfactory result, considering the displacement of the ship, and especially her extremely low coal consumption.

A New Trunk Deck Cargo Steamer.

BY BENJAMIN TAYLOR.

We present particulars of the steel screw cargo steamer *Romanby*, built by Ropner & Sons, Ltd., Stockton-on-Tees, for British owners. She was built to the highest class of British Corporation, and is fitted with the patent improved trunk deck of the builders with clear holds and deep frames. The dimensions of the vessel are:

Length	365 feet
Breadth	50 feet
Depth	23 feet

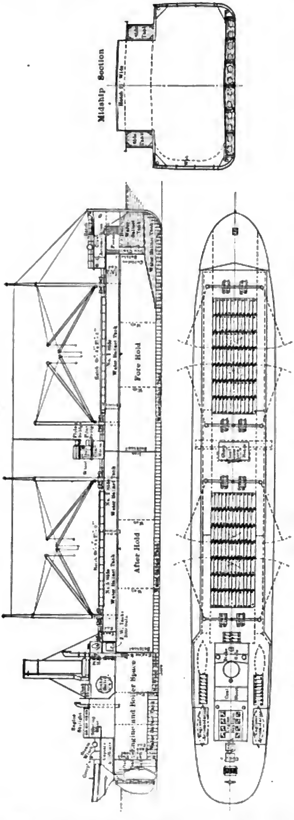
The saloon house, with accommodation for captain and officers and a house for engineers, is fitted up on trunk deck, with the crew in topgallant forecastle and apprentices aft.

The vessel has double bottom for water ballast on the cellular principle, also in the fore and after peaks. The deadweight-carrying capacity is about 6,100 tons on summer freeboard. She is fully equipped with an up-to-date outfit, including a quick-warping windlass, stockless anchors, steam steering gear amidships, with powerful screw gear aft. The appliances for loading and discharging expeditiously are very complete, and include extra derrick posts and double derricks and nine steam winches, steam being supplied by a horizontal multitubular donkey boiler, 10 feet diameter and 10 feet long.

The engine is of the triple expansion type, with cylinders 25, 41 and 67 inches in diameter by 45-inch stroke, and of 1,500 indicated horsepower. Steam is supplied by two large single-ended main boilers, 16 feet in diameter by 10 feet 6 inches long, at a working pressure of 180 pounds per square inch. These boilers are fitted with Brown's improved patent furnaces.

The *Romanby* will carry 6,200 tons on the low draft of 21 feet 4 inches. She has very clear holds. Her frames are bulb angles with no hold beams, wide stringers, or quarter pillars; a few center line pillars are fitted, to carry shifting boards. This type of vessel is very suitable for the grain trade, as the trunk forms a permanent feeder, and there is consequently no danger from grain cargo shifting, and bagging is reduced to a minimum. This steamer will also carry timber cargoes very successfully, as the space within the trunk secures full freightage, and the trunk forms a key to which the deck cargo is secured, to prevent any possibility of its being carried away.

A similar steamer, for the coal-carrying trade, is fitted with large deck water ballast tanks situated within the trunk, which



PROFILE, DECK PLAN AND MIDSHIP SECTION OF A VESSEL OF THE TYPE OF THE ROMANBY, BUILT BY ROPNER & SONS, STOCKTON-ON-TEES.

makes a very steady ship when in light trim in rough weather. This coal steamer has two holds, or, if considered necessary, only one hold, with two long hatches, from 70 to 100 feet in length, and from 27 to 32 feet in breadth.

This type of patent trunk steamer is claimed to be the ideal cargo carrier, because the ships are self trimming, have clear holds and no obstructions, involve the minimum of coal-burning charges, have large cubical capacity with either single or double decks, take a very high percentage of cargo per net register ton, carry water ballast in trunk tanks well in from the ship's side and secure from external damage, permit of no damage to perishable cargoes from condensation, have continuous hold and wide hatchways, have very light draft for large deadweight, are very "sea-kindly" when in ballast trim, and are the easiest vessels afloat to load and discharge.

We give sections of a steamer of the *Romanby* type, specially adapted for coal and ore carrying.

The Cargo Steamer Echunga.

The *Echunga* is the largest of the cantilever framed top-side tank steamers, with complete shelter deck for horses or cattle, yet built by Sir Raylton Dixon & Company, Ltd., Middlesbrough, and has been designed and constructed to fulfil the very special requirements of the extensive coal, ore and cattle trade carried on by her owners, the Adelaide Steamship Company, Ltd., of Adelaide, South Australia. She is considered by experts to be one of the most complete and up-to-date cargo boats afloat.

Her leading dimensions are 405 feet in length, 56 feet beam, and 26 feet 8 inches molded depth, and she will carry about 8,400 tons on her assigned loadline, and has capacity for over 11,000 tons measurement cargo.

Her leading features place this vessel among the most effectively equipped cargo boats. In the first place she will carry a dead weight of about three and three-quarter times her net register tonnage, the latter being 2,245, and the former 8,400 tons on 23 feet 9 inches draft. Her water-ballast tanks will contain 3,200 tons, of which 1,350 is placed in the top-side tanks, and the remainder in double bottom and peaks, and when the vessel is to sail in ballast trim, the propeller will be immersed, and she will consequently be in extra trim for speed results and good sea-going condition. Her five hatchways are of extraordinary size, all being 30 feet wide, and the longest 42 feet long. She is a perfect self-trimmer, and her holds are absolutely clear of any obstruction, such as beams, webs or pillars. She has unique facilities for loading and discharging her cargo, being fitted with no less than fourteen derricks and eight gaffs; and having twenty-five extra powerful steam winches, which will enable thirty-two gangs of coal heavers to discharge her 8,400 tons of coal in 48 hours.

The vessel has a complete shelter deck all fore and aft. A large steel deck house is fitted on shelter deck amidships for officers' berths and saloon, with captain's room and wheel house above, and flying bridge on top of latter. The accommodation for engineers is provided in a large steel house aft, while the crew are berthed in shelter deck aft, and cattlemen in forecastle. The facilities for loading and discharging the cargo consist of two heavy masts, two crane posts, and cargo span. There are six derricks and four heavy gaffs on each mast, the two center derricks being equal to a working load of 10 tons, while the four side derricks will lift 8 tons each. On each gaff are three special gins for whipping coal, and a heavy steel derrick capable of lifting 20 tons is fitted on the mainmast. To work all this gear there are, around each mast, six special powerful steam winches, with cylinders 8 by 12 inches, and also four very heavy and specially designed frictional winches, and two ordinary winches at each crane post, making a total of twenty-five steam winches, including a very heavy warping winch, having cylinders 10 by 16 inches. This winch is placed aft in deck house, and is fitted with heavy extended warping ends, and on the main shaft there are also steering chain bands, fitted so that the winch could act as steering gear if necessary.

The shelter deck and 'tween decks are especially arranged

for cattle, horses or troops, and a complete system of cattle watering arrangement is provided, both in 'tween and on shelter decks. Heavy stanchions are fitted around the shelter deck, at suitable distances apart, to which wood framing for the exposed cattle pens may be attached. The vessel is otherwise very complete in accommodation for officers, crew and cattlemen, and has a complete installation of electric light.

Triple expansion engines, which are placed right aft, have been fitted by Messrs. Richardsons, Westgarth & Company, Ltd., Middlesbrough, having cylinders 27½, 44 and 75 inches in diameter, by 48 inches stroke, supplied with steam by four large single-ended boilers, working at 180 pounds per square inch. The trial trips passed off most successfully, the vessel attaining a speed of 12¾ knots. The ship was built to the highest class in the British Corporation.

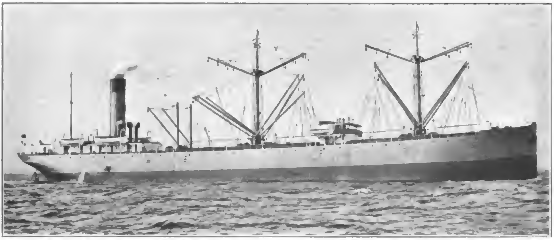
The Largest French Cargo Boat.

This steamer, *Meinam*, has been built by the Palmer's Shipbuilding Company for the account of the Messageries Maritimes. She is the largest purely cargo steamer of the French mercantile fleet, and has the following particulars:

Length over all..................	436 feet
Length between perpendiculars....	411 feet
Extreme breadth.................	52 feet 5 inches
Depth molded....................	29 feet 9 inches
Gross register tonnage...........	5,420 tons
Deadweight tonnage..............	12,000 tons

The steamer is given the highest class in the British Corporation Register, and is built to Board of Trade regulations, on the deep frame and girder system. She is rigged as a two-masted schooner, is fitted with a long bridge house amidships, has a full poop and topgallant forecastle, and three steel decks worked from end to end. The ship has a cellular double bottom for water ballast, and is divided into nine watertight compartments.

The accommodations for the captain, officers and engineers are in the deckhouse on top of the bridge deck. All accommodations are commodiously and tastefully fitted out. The



THE LARGE CARGO STEAMER ECHUNGA, BUILT BY SIR RAYLTON DIXON & COMPANY.

THE STEAMSHIP MEINAM, THE LARGEST CARGO STEAMER FLYING THE FRENCH FLAG.

Recent figures show that the British navy contains active vessels aggregating 1,590,006 tons, or 42.4 percent of the total accredited to the seven leading naval powers. The United States is second, with 517,775 tons, and 13.8 percent. France has 493,392 tons and 13.1 percent; Germany, 435,773 tons and 11.6 percent; Japan, 344,979 tons and 9.1 percent; Russia, 219,633 tons and 5.8 percent, and Italy, 156,312 tons and 4.2 percent. The four continental navies contain 1,305,110 tons, or 34.7 percent of the total.

main 'tween decks are 11 feet in height, which will give ample space for the carrying of horses, should this be necessary. There are large cargo hatches, and thirteen steam winches, with ample derrick accommodations, one being of 30 tons capacity, two of 10 tons, and twelve of 5 tons each, or fifteen derricks in all. They are provided for the rapid discharge of the cargo. The vessel is fully equipped with modern conveniences, including electric light.

The main engines are two in number, of the triple expansion, three-cylinder type, the cylinders being, respectively, 26, 45 and 76 inches in diameter; the stroke is 54 inches. The total indicated horsepower is 1,700. Steam is supplied to the main engines by three cylindrical boilers of the usual type, being 15 feet in diameter and 12 feet in length. They are fitted with the Howden's forced draft system.

This steamer, having been built to get the subsidy according to the April, 1906, regulations, and having a gross register of 5,420 tons, and having a trial speed over 10 knots, will, therefore, get as "compensation d'armement" during twelve years:

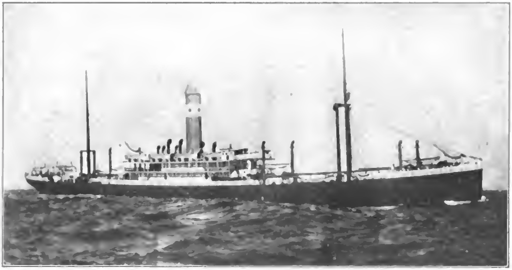
$$\begin{array}{rl} \text{fr. } 0.04 \times 3{,}000 \text{ tons} = & \text{fr. } 120 \\ 0.03 \times 2{,}420 \text{ tons} = & 72.60 \\ \hline & \text{fr. } 192.60 \text{ per day,} \end{array}$$

or fr. 69,336 per year. During the life of the subsidy, this will amount (assuming constant operation) to fr. 832,032 (£33,000 or $160,582).

This steamer is given the highest class in the French Veritas. She has been built on the deep frame and girder system, and is rigged as a two-masted schooner. There are three decks worked from stem to stern; above the main deck there is a top gallant forecastle, 55 feet in length, in which the crew, the petty officers and stewards are berthed.

Amidships there is a long bridge house, 182 feet in length, in which accommodations are provided for fifty-seven first class passengers in very roomy cabins; the staterooms being situated in the bridge, on the bridge in deck houses, and also in deck houses above that again. The dining saloon is at the front end of the bridge, and a drawing room and a smoking room are also provided, with several "en suite" rooms. The furnishing and outfit are severely plain, but they are especially suited for hot climates. Accommodations are also provided for steerage passengers, who will be located in the first 'tween deck. Aft there is a full poop, with accommodations for officers and a few passengers; the poop has a total length of 33 feet 6 inches.

The ship is divided into eleven watertight compartments, and a complete cellular double bottom extends from end to end. The total capacity of water in this double bottom is 1,322 tons; fore and aft in peaks 210 tons, and in special holds amidships 1,982 tons of water might be shipped; the total water carried on ballast trim therefore is 3,514 tons, which allows good seaworthiness to the ship for running long distances on ballast.



THE STEAMSHIP MALTE AT SEA, FULLY LOADED WITH 9,000 TONS OF COAL.

A Large French Steamer.

BY J. G. PELTER.

The steamship *Malte*, built to the order of La Compagnie des Chargeurs Réunis, of Paris and Havre, by Swan, Hunter & Wigham Richardson, Wallsend-on-Tyne, is the first merchantman of the French fleet built especially for an all-around-the-world service.

This steamer has the following particulars:

	Meters.	Ft.	Ins.
Length between perpendiculars	147.21	483	
Breadth	16.95	55	8
Depth	10.36	34	
Draft, full loaded	7.32	24	
Gross tonnage (tons)			8,321
Net tonnage (tons)			5,606
Deadweight capacity (tons)			9,500
Indicated horsepower			5,800
Mean full speed on trials (knots)			14.5

The main 'tween decks are very high, which allows the carrying of horses or cattle. The handling of the cargo has been specially well studied. There are not less than fourteen powerful winches, with latest type of derrick accommodations; the most powerful winch can lift 40 tons, and the smallest 5 tons. Everything has been designed for a quick discharging or loading of the cargo.

The ship is fully equipped with the most modern conveniences, including electric light and a complete refrigerating plant on Hall's CO_2 system, which allows the ship to carry perishable cargo.

The vessel is propelled by twin screws, driven by two engines of the triple expansion, three-cylinder type, which, at ninety revolutions per minute, have developed an average of 5,800 indicated horsepower. The contract conditions as regards speed were somewhat severe, the vessel having to run for a 4-hour full power trial, and subsequently a 24-hour consumption trial. On Sept. 2 last, during the former, the mean

THE STEAMSHIP MALTE IN ST. NAZAIRE DOCK, PREVIOUS TO OFFICIAL TRIALS.

indicated horsepower developed considerably exceeded the guaranteed power; the 24-hour trial was equally successful, the vessel attaining a mean speed of over 14½ knots, the guaranteed speed being only 13½ knots.

The main engines have cylinder diameters of 25½, 43 and 70 inches, and the stroke is 48 inches. The main and auxiliary engines receive steam from six cylindrical boilers of the usual type, being 11 feet 9 inches in length and 15 feet 3 inches in diameter; there are 18 furnaces. The total surface of grate is 366 square feet, and the heating surface 15,660 square feet, giving a ratio of 42.8 to 1. The boilers are fitted with Howden's forced draft system. The normal pressure in the boilers is 200 pounds per square inch.

The steamer came to St. Nazaire with 9,000 tons of coal and was measured by customs officials; afterwards she made her official trials for the "subsidy," and then took 5,000 tons of patent fuel for the Saigon dockyard. On leaving St. Nazaire she went to Antwerp, then to Dunkirk, and has left for her maiden trip via Suez Canal, Singapore, Hong Kong, Shanghai and other Eastern ports; thence via the Pacific to various ports on the west and east coasts of South America, and subsequently to the United Kingdom, France and Antwerp. Such a trip is expected to last 240 days.

The Steamship Tosno.

This vessel was built and engined by Earle's Shipbuilding & Engineering Company, Ltd., of Hull, to the order of Thomas Wilson, Sons & Company, Ltd. The ship is intended for passenger and general cargo trade between St. Petersburg and Hull, and is a sister ship to the *Kovno*, which runs in the same trade in conjunction with the *Kolpino*. The *Tosno* is a handsomely modeled vessel, 318 feet long by 41 feet beam and 21 feet molded depth, and has a gross tonnage of 1,985. She maintained on trial an average speed of 13 knots.

The passenger accommodation is of a superior character, and, combined with quick steaming, should make her a favorite boat to and from St. Petersburg, the time occupied by the passage under favorable weather conditions being considerably shortened. There is accommodation for twenty-four first-class passengers, the staterooms being grouped amidships on the

THE STEAMER KOLPINO, RUNNING BETWEEN HULL AND ST. PETERSBURG.

THE STEAMSHIP TOSNO, JUST BEFORE HER LAUNCHING AT HULL.

starboard side. The rooms are large, well lighted and ventilated and are fitted with all modern appliances and conveniences. The saloon and social hall are built of solid oak, set off in panels, and are well upholstered. There is a fine promenade deck over the saloon, also a large poop deck aft, both available for passengers. Large and comfortable quarters have been arranged for captain, officers and crew.

The machinery consists of a triple-expansion engine supplied with steam from two large single-ended boilers working at a pressure of 200 pounds per square inch, and fitted with forced draft on the closed ashpit system. The vessel is lighted throughout by electricity, and is fitted with the latest appliances for expeditiously dealing with cargo, weights up to 15 tons being handled without the assistance of shore cranes.

JAMES FISHER.

A Large Italian Emigrant Steamer.

The twin screw steamer *Venezia*, one of the latest of the Fabre Line, was launched April 30, 1907, from the Neptune Works of Swan, Hunter & Wigham Richardson, Ltd. This steamer was constructed to the order of Messrs. Cyprien Fabre & Company, Marseilles, for their emigrant service between Italy and New York. She is a handsomely modeled vessel, built of steel to the highest class in the register of the Bureau Veritas, and to comply with the Italian and American emigrant regulations. There are eight watertight compartments.

She is propelled by two triple-expansion engines supplied with steam from six large Scotch boilers. Both engines and boilers were also constructed at the Neptune Works, the engines having cylinders 29½, 48 and 77 inches in diameter, and a stroke of 45 inches. They were expected to drive the *Venezia* at a speed of over 16½ knots, and the trial yielded 17½ knots.

THE STEAMER TOSNO, OF THE HULL AND ST. PETERSBURG SERVICE.

Vickers, Sons & Maxim, Ltd., report for 1907 total profits of £768,525 ($3,739,932), from which an ordinary dividend of 15 percent has been paid.

The vessel is about 470 feet in length (457 feet between perpendiculars) by 51½ feet beam and 22¾ feet depth. Her tonnages are 6,733 gross and 3,802 net. She is fitted with accommodation for 50 first class passengers, consisting of a large dining saloon, writing room, smoke room, ladies' room, twenty-four staterooms and one cabine de luxe, all situated in houses on the bridge deck and above. The remainder of the ship is fitted up for emigrants, over 1,800 in all, in addition to which there are hospitals containing sixty beds. J. & E. Hall, London, are the makers of the refrigerating installation fitted on board.

On her maiden voyage the ship reached New York on Oct. 1, 1907, carrying 71 cabin and 1,852 steerage passengers.

LAUNCHING OF THE STEAMSHIP VENEZIA FROM THE YARD OF SWAN, HUNTER & WIGHAM RICHARDSON.

LAUNCHING OF THE NEW ZEALAND TURBINE STEAMER MAORI AT DUMBARTON.

New Zealand Liner Maori.

BY BENJAMIN TAYLOR.

A turbine steamer, *Maori*, has been built by William Denny & Brothers, Dumbarton, for the Union Steamship Company, of New Zealand. The Union Company, quick to note the advantages of the turbine system of propulsion, was the first to introduce this system to the Southern Hemisphere. Three years' experience of the *Loongana* has justified the step, and the *Maori* is an enlarged vessel of the same type, embodying the results of that experience. The principal dimensions are: Length, 350 feet; molded breadth and depth, 47 and 26 feet.

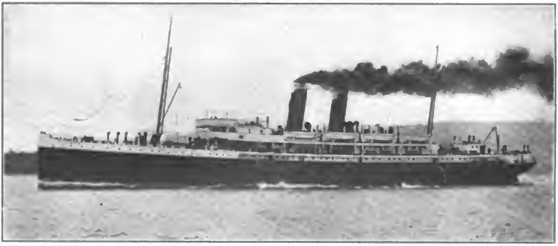
As the vessel is intended to run in connection with the railways, the appliances for handling her are extremely powerful, and consist of a steam windlass and capstan on the forecastle and a powerful warping winch at the stern, the latter being arranged to work derricks which are provided for dealing with the mails and baggage. Large rudders are fitted both at bow and stern. The after rudder is actuated by Brown's patent steam tiller, controlled by telemotor from the flying bridge, and the forward rudder is worked by Hastie's steam steering gear, situated on the rudder head and controlled by large wheel, also on the flying bridge. The vessel has eight large boats carried on a boat deck amidships, and a special steam winch is provided for rapidly hoisting them. All boats are carried on special dropping chocks, which enables them to get clear in a few seconds in an emergency.

The propelling machinery consists of three sets of turbines, on the Parsons principle, all, with the boilers, being constructed by Messrs. Denny. A complete installation of electric light is fitted in the vessel by the builders.

Being primarily intended for the night mail service between Wellington and Lyttelton, New Zealand, almost the whole of the vessel is devoted to passenger accommodation. There is a shade deck extending from the stem almost to the stern, on which is situated the first class music room, a large apartment designed in mahogany and finished in white enamel. The furniture is in dark mahogany, and includes an artistic music cabinet with bevelled glass panels. The ceiling is in strap work, finished in pale tint. The lighting is by means of large rectangular windows of Broadfoot's make, and by a well in the center, panelled in the Adams style, and surmounted by a teak skylight with stained glass windows. The upholstery is carried out in silk tapestry, with curtains of similar material in pale green and cream shades. The floor is laid with Wilton carpet of a blue tone. Abaft the music room is the principal companion and vestibule, of a classic design, framed in padouk and panelled in figured mahogany. On

either side of the entrance doors spaces are reserved for Maori native carving.

extension, and can be fitted up to accommodate fifty additional passengers in the busy season.



THE TURBINE STEAMER MAORI, BUILT AT DUMBARTON FOR SERVICE IN NEW ZEALAND WATERS.

Amidships, on this deck, is the first class smoking room, of simple classic design, executed in teak and Hungarian ash. The roof of this apartment is raised in the center with a deep frieze in root veneer, a material also used in the dado bands, alternating with panels of figured kauri. The upholstery is in uncut moquette of olive color.

The deck below is the upper deck of the vessel, the forward end of which is devoted to seamen's and firemen's accommodation, with separate messrooms, bathrooms and lavatories, spacious and comfortable. The amidship portion of the vessel is occupied with first class staterooms. In the center is a large vestibule of a design similar to the upper vestibule, framed in walnut.

The main deck is fitted up for first class passengers, from the chain locker as far aft as the forward funnel; also along the port side of machinery space; the starboard side being devoted to the culinary department, which is fitted out with all the latest cooking and baking appliances. The engineers are berthed on this deck alongside of the engine room. The space abaft the turbine hatch is fitted up for second class passengers. The forward end of the lower deck is devoted to the accommodation of seamen, firemen, greasers and petty officers. These have large spaces for their accommodation, and there are not more than eight berths in any one room.

Abaft the forward hatch on this deck is the first class dining saloon, the design of which is of a classical type, executed in mahogany, finished in enamel white. The panels have arched tops, and are provided with a raised ornament. The furniture is in light oak, and here also spaces are reserved for Maori carving. The sideboards are fine pieces of furniture. This saloon is lighted by large sidelights and also by a well, which is treated similarly to the saloon design. The ceiling is in an interlaced design, with narrow panels of anaglypta, finished in pale tints relieved with gold. The upholstery is in uncut moquette. The curtains are of silk tapestry in various shades of pale green, and the floor is covered with Wilton carpet of a rich crimson color.

Abaft the machinery is the second class dining saloon, which is framed in mahogany and finished in white enamel similarly to the first class saloon. The upholstery is in blue and gold carriage cloth. The floor is laid with Brussels carpet runners, and artistic curtains are fitted to the windows. The after end of the lower deck is arranged for a temporary second class

AN INCLINING EXPERIMENT.*

BY HAROLD F. NORTON.

It seems quite the natural thing that a ship should stand up straight in the water, and most of them do, but now and then one does not, and, of course, the consequence is disastrous. For instance, not long ago there was launched at an Italian shipyard a ship which promptly turned over as soon as she was afloat, and sank in deep water, while her builders stood helplessly on shore and watched months of labor and hundreds of thousands of dollars of expense sink beneath the waves. Why was it? What was wrong? If you ask a naval architect he will tell you that she had a negative $G\ M$.

Now, that sounds innocent enough, but it may be seen to be a matter of some importance to determine that a ship has a positive $G\ M$ before she is too fully trusted to the element for which she is intended. Of course, in the books on naval architecture, it may soon be found just what a positive $G\ M$ is, and by what process it is determined that any ship is properly in possession of one, but it may be of interest to know just how the government assures itself that the vessels built for it are all right in this respect, and so I venture to describe the process called an "Inclining Experiment," as performed on one of the late battleships built at the yard of the Newport News Shipbuilding & Dry-Dock Company.

For the benefit of those who are generally interested in engineering subjects, but have not specialized in this particular line, it may be well to explain upon what principles an inclining experiment is based, and how it accomplishes its purpose.

A ship at rest in smooth water, for small inclinations, behaves remarkably like a pendulum (see Fig. 1). That is, it acts exactly as though the mass of the ship, or its center of gravity, were suspended from a point in space which we may imagine to be the center of suspension of the pendulum. This point in space is called the metacenter. Now, calling this point M, the center of gravity of the ship G and the distance between them $G\ M$ (Fig. 1), the importance of $G\ M$ will immediately appear. If $G\ M$ is positive, that is, if the point M lies above G, the ship will stand up straight and true in quiet water, just as the pendulum will hang straight and true if the center of suspension is above the bob. Also, if $G\ M$ is negative, that is, if the point M is below G, the ship will promptly turn over,

* *The Sibley Journal of Engineering.*

just as the pendulum will turn over if its point of suspension is below the bob. Moreover, if the ship is slightly inclined from the perpendicular by any external force and then freed, she will swing back and forth, and finally return to the perpendicular, exactly as the pendulum will. The righting moment, as it is called, will be exactly the same as for the pendulum, that is, the weight of the ship, times $G\,M$, times the sine of the angle of inclination.

$$\text{Righting moment} = W \times G\,M \times \sin\alpha \qquad (1)$$

This is explained from Fig. 1, where righting moment $= R \times O\,M$.

$$R = W \tan\alpha = W \times \frac{\sin\alpha}{\cos\alpha}$$

$$O\,M = G\,M \cos\alpha,$$

whence $R \times O\,M$ (righting moment) $= W \times G\,M \times \sin\alpha$.

Of course, it must be understood that in Fig. 1 the conditions for the ship are exaggerated. For purposes of illustration, the inclination is shown large, and the distance of M above G relatively much larger than would ordinarily be the case. It will be noticed that the ship acts rather the reverse of the pendulum, for if the ship is inclined to the right, G is displaced to the left of the perpendicular through M, and *vice versa*. Also, the ship does not swing about the point M as a center, but about quite another point near the waterline, called the point of oscillation. However, for all static forces involved, she acts as though she were suspended from the point M.

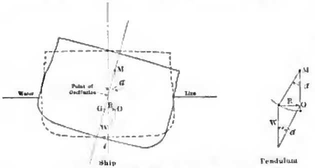


FIG. 1.—THE ANALOGY BETWEEN THE SHIP AND THE PENDULUM.

Now the point M is quite easy to locate for any given ship, submerged to any given waterline, from purely mathematical considerations of the form of the ship. Suffice it to say that its distance above the bottom of the ship, or base line, is equal to the moment of inertia of the waterline to which the ship is submerged, divided by the volume of water displaced, plus the distance of the center of gravity of the displaced water above the base.

On the other hand, the exact location of the point G, that is, the center of gravity of the ship's structure and the various things she contains, is extremely difficult to obtain. Of course, it may be approximated by carefully estimating the weight of every member of the ship's structure and every article she contains, summing the moments of all above the base, and dividing by the total weight. In fact, that is the only way to obtain it before the ship is launched and actually afloat in the water, and that is the only way to guard against such an accident as that cited above. However, it is at best a laborious process, and only very approximate. For launching purposes it is ordinarily quite sufficient, for the point G is usually much below the point M, in launching condition. If such an approximate calculation as the above indicated them to be at all close together, special precautions would immediately be taken for the safety of the ship by filling one of her water bottoms, and thus lowering the point G.

After the ship is in the water, the inclining experiment furnishes a ready and easy means of obtaining, with very fair accuracy, the value of $G\,M$ and the location of G. At this time also it is of importance that such an accurate location should be obtained, for as the ship is more and more completed, more and more weights are added, and these are usually weights in the upper part of the ship. The point G climbs higher and higher, of course M climbing also as the ship goes down in the water, and it is of importance to make certain that there is no danger of G's ever catching up with M. Also, when the ship is nearly or quite completed, it is well to perform another inclining experiment. If she is a merchant vessel she is to receive her cargo, and it must be made certain that, whatever its character, there shall never be any danger of a negative $G\,M$. If she is a warship, she is to receive her ammunition, stores and equipment, and the same care must be taken regarding every possible distribution of these. For these reasons the government usually requires two inclining experiments, one soon after launching, and one as nearly as convenient to the completion of the vessel. The one we are about to describe was that performed near the completion of the vessel.

An inclining experiment is based simply upon the principle mentioned in the beginning of this article, that for a small inclination of the ship, the inclining moment, which is, of course, equal to the righting moment, is equal to the weight of the ship, times $G\,M$, times the sine of the angle of inclination. If the ship is inclined by moving a weight across the deck, the inclining moment is simply the weight, multiplied by the distance through which it is moved. Thus, if we call the weight of the ship W, the weight which is moved across the deck w, the distance it is moved d, and the angle of inclination α, we have (see Figs. 1 and 2):

$$w \times d = G\,M \times W \times \sin\alpha, \qquad (2)$$

$$\text{or, } G\,M = \frac{w \times d}{W} \times \cot\alpha.^{*} \qquad (3)$$

Since all the quantities on the right-hand side of equation 3 are known, or may be readily and accurately measured, we have directly obtained a very fairly accurate value of $G\,M$. Then, since we have seen above that the distance of M above the base may be calculated with fair accuracy, we may obtain the distance of G above the base, by subtraction, and any subsequent changes in the location of G, due to weights which must be added, or those which must be removed, may be very closely approximated.

The angle of inclination is obtained by means of one or more plumb-bobs. Battens are fixed at a known distance below the point of suspension of the plumb-bobs, arranged so that they are approximately perpendicular to the plumb lines when the ship is on an even keel, and so that the plumb lines shall hang close to the battens. The point where the line crosses the batten is then marked, and when the ship heels, one way or the other, the deflection of the plumb line from this point is noted. The cotangent of the angle of inclination may then be directly obtained by dividing the distance from the point of suspension to the batten, by the deflection as measured on the batten. This is evident from Fig. 2, where it may be seen that $OA \div AB = \cot\alpha$.

In the experiment we are describing, the weight moved consisted of a pile of pig iron on the upper deck near the midship frame. In order that the weight might be accurately placed, two rows of planks were laid on each side of the deck near the gunwales, so that the half-pigs, when laid across them, came just to the edges of the planks, about as shown. The distance between the centers of the two rows of planks was arranged to be 66 feet. Two plumb-bobs or pendulums were arranged, one forward and one aft, hung from planks laid across the coamings of hatches on the main deck, the lines hanging down the hatches and the bobs swinging just

* Properly, cosecant α, but, for the small inclinations involved, the cotangent is virtually identical with this, and is more easily measured.

clear of the lower platform deck. The battens for measuring deflection were then laid across horses set on the lower platform deck. The lengths of pendulums, or distance from the planks across the main deck hatches, to the battens just above lower platform, were then measured by dropping down a steel tape. The total weight of pig iron was 50.03 tons, and this had been carefully weighed and divided into two sections of 25.02 and 25.01 tons, respectively, the pigs of one section being marked with white, and those of the other with black paint, to distinguish them.

The experiment was started with all the weight piled on the port side of the ship. Half of it, the white pigs, 25.02 tons, was then carried across and laid on the starboard side, and a reading taken of the movement of the plumb lines across the battens. The remainder was then carried across to the starboard side and another reading taken. This half, the black pigs, was then carried back to the port side, and another reading taken. The white pigs were then carried back and a final reading taken. The results are set down in the table. It will be seen that the return readings checked very well with the first, those on the forward pendulum being exactly the same, and those on the after one very close.

Of course, it must be explained that, in preparation for the inclining experiment, the ship had been carefully gone over to see that there was no free water anywhere, and to take account of all weights on board which were not to remain there ultimately, or of any which were lacking to bring the ship to a completed condition, in order that proper allowance might be made afterward in calculating the $G\ M$ of the ship as completed. In the same way, it was necessary to deduct the weight of the pig iron used in inclining, the weight of the men employed to transport the pig iron across the deck, and of those occupied in directing the experiment and observing the pendulums. All other men were, of course, excluded from the vessel, and at the time readings were taken, all those on the ship were required to stand near the centerline, in order that even this small weight might not affect the readings.

INCLINING EXPERIMENT.

Ship as Inclined.—Practically completed, except certain battery weights and magazine equipments; no boats on board; some coal in bunkers; no water in bottom, bilges or tanks.

Draft.—Forward 21 feet 6¾ inches, aft 24 feet 6¼ inches, mean 23 feet ½ inch.

Density of Water.—Cubic feet per ton, 35.48.

Displacement.—Corrected for trim and density of water, 14,685.54 tons.

Inclining Weights.—50.03 tons on upper deck.

Pendulums.—Forward, length 370.50 inches, hung from main deck frames 18 and 19.

Pendulums.—Aft, length 377.75 inches, hung from main deck frames 94 and 95.

Inclinations.		Weight Moved (Tons).	Distance Moved (Feet).	Moments of Inclining Weights (Foot-tons).	Deflection of Pendulum (Inches). Starboard	Deflection of Pendulum (Inches). Port.	Length of Pendulum (Inches).	Cotangent	Mean Cotangent.	G. M. (Feet).
1st	For'd... Mid's.. Aft..	25 02	66 00	1651 32	10 25	...	370 50	36 15	36 40	4 093
					10 31		377 75	36 64		
2d....	For'd... Mid's.. Aft...	25 01	66 00	1650 66	10 13		370 50	36 57	36 48	4 100
					10 38		377 75	36 39		
3d....	For'd... Mid's.. Aft....	25 02	66 00	1651 32		10 13	370 50	36 57	36 28	4 070
						10 50	377 75	35 98		
4th...	For'd... Mid's... Aft....	25 01	66 00	1650 66		10 25	370 50	36 15	36 48	4 100
						10 25	377 75	36 80		
Mean metacentric height									...	4 09

In order that the inclinations might not be affected by the ship's touching a pier, or by the pull of any lines, she was hauled out between two piers quite clear of either of them, and all lines were slacked at the time readings were taken. Also, care was taken to choose a time for performing the experiment, when there was little or no wind, and the water was perfectly quiet.

The drafts forward and aft were carefully read, the density of the water tested, and the exact displacement taken from the displacement curve, with due allowance for trim and for

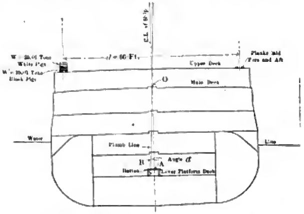


FIG. 2.—OUTLINE SECTION, SHOWING INCLINATION TO SCALE.

density of the water. This displacement, 14,685.54 tons, was then used in obtaining the values of $G\ M$ set down in the table. For instance, for the first reading:

$$G\ M = \frac{w \times d}{W} \times \cot \alpha. \qquad (3)$$

$w \times d = 25.02$ tons $\times$ 66 feet. $= 1{,}651.32$ foot-tons, moment of the inclining weight.

$$\cot \alpha, \text{ for forward pendulum} = \frac{370.50}{10.25} = 36.15,$$

$$\cot \alpha, \text{ for after pendulum} = \frac{377.75}{10.31} = 36.64.$$

Mean $\cot \alpha = 36.40$,

W = displacement = 14,685.54 tons.

$$G\ M = \frac{1{,}651.32}{14{,}685.54} \times 36.40 = 4.093 \text{ feet.}$$

It is not universally conceded to be good practice to begin the experiment except with the ship on an even keel. There seems very little valid objection, however, to beginning as above, with the ship inclined to one side, except that it is not practicable to set the deflection battens accurately perpendicular to what will be the hang of the plumb lines when the ship is on an even keel, and the drafts cannot properly be read before the experiment begins. If, however, the deflection battens are placed parallel with a deck, they will be so nearly perpendicular to the plumb lines, with the ship on an even keel, that considering the great length of the pendulums and the comparative smallness of the deflections, the error is practically negligible. If, then, the draft readings are taken when half the weight is on each side, the above method of performing the experiment would seem to possess no special disadvantages, and it has the great advantage of convenience, since the weight may all be hoisted directly from a pier to one side of the vessel, at the beginning of the experiment, and when the experiment is over it is all back on the same side, ready to be lowered to the same pier.

SAIL MAKING.

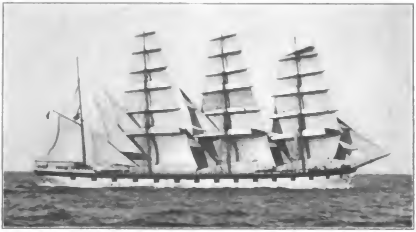
BY ADRIAN WILSON.

There is, without doubt, a limited demand for some good, reliable work on the making of sails. Only one or two books have been written on the subject, and they are really of no use to the ordinary yachtsman, and of little practical value to a sailmaker. What little has been written applies only to the making of square sails used on merchant ships. The only valuable book of this kind is one written in England by a practical sailmaker named Dice, on the cutting and making of jibs or headsails. It is a book of real value, as it treats of the matter in a really practical and scientific manner. Mr. Dice's ideas we believe to be original and his conclusions sound; and, having put many of his ideas to practical use, we have proved them to our satisfaction to be of value. All other works on the subject we have found to be simply useless to anyone except a practical sailmaker. These works, as a rule, consist of a lot of matter used by the ordinary master sailmaker in laying down and cutting sails. If read by the ordinary yachtsman he would probably know about as much in regard to sail making at the start as he would at the finish. I am of the opinion that any attempt to write up the subject, so as to make it an intelligent or enlightening book, would result in a failure. There are so few to whom it would be of real benefit that it would be a useless waste of time.

In our work as sailmakers we have learned, through long experience, certain established facts and principles that are of great value to us and also to our customers. One trade secret is worth more than all the patents ever issued. Through long experience and accumulation of certain details we have collected together much valuable data in our line of work; especially has it been our good fortune to get the facts together through our experience in making sails for racing yachts. Opportunity has presented itself by our ability to see the sails in actual use and in all conditions of weather. This opportunity, together with the training of intelligent workmen, has enabled us to direct the cunning hand of skilled mechanics to produce results which have turned out racing sails that lead the world in attainment of speed in sailing yachts.

While we have made it a point for years to say as little as possible about the cut and making of American racing canvas, we believe the time has come when the protection of our interests makes it necessary that we put something into the hands of our customers that shall give them an intelligent understanding of why we do certain things, and shall help them to carry out, in the use of their sails, the work begun in the sail loft. It is a fact that more poor sails are made on yachts than in sail lofts. By this I mean that as much, or even more, depends on the intelligent handling of sails as in their making. The sailmaker can use all of his skill in the making of a racing suit, and spend days on its construction, yet it may all be lost, or thrown away, by the handling it receives when put on board the yacht.

Now comes the question as to what are the principal elements of the best racing sail; on what principle is it constructed that gives it real value as a racing sail? There are some very opposite opinions on this question. It has been a question for some years as to the superiority of English vs. American sails, or *vice versa*. On this point are two directly opposite opinions. The English designers and sailmakers believe in a flat surface or straight plane for the fore and aft body of their sails.



ON THE WIND. THE FOUR-MASTER AFGHANISTAN (Photographs, N. L. Stebbins.) BROADSIDE VIEW.

THE SCHOONER YACHT DERVISH. (Photograph, N. L. Stebbins.)

At the time the yacht *America* sailed her famous race at Cowes, the English yachtsmen were thoroughly convinced that her victory was due to the fact that her sails were perfectly flat. This was not a fact. The sails of the *America* were made by the writer's father, R. H. Wilson, of Port Jefferson, N. Y.: and while, in comparison with the sails made in

England at that time, they had the appearance of perfectly flat planes, they were in reality no such thing. There was a certain curved line in these sails that was almost as near the correct thing as it was possible to make, and no improvement has been made in sails from that day to the present time; nor is it possible to improve on them, as this curve or draft was about as nearly perfect as possible. The *America's* sails were made of cotton duck, especially made for this suit of sails by John Colt, of Passaic, N. J. The superiority of this fabric over the flax or hemp duck used on the English yachts, which was a soft, flabby material and cut with a great amonnt of bag, was at once demonstrated by the ability of the *America* to cut-point and out-foot the English boats.

If the reader cares to look up the records of the races sailed for the *America's* cup, he will find that all of the American victories have been due to the fact that the American boats are faster in windward work. In some of the later races sailed for the cup the English yachts have shown that they could do better than the American yachts in both reaching and running,

We would begin by giving our readers our experience as to the best forms of sails. Some of our measurement rules are directly responsible for badly proportioned sails. I have always contended that sails should be measured by their actual areas, and should not be computed from measurements taken by measuring the spars. The Massachusetts Yacht Racing Association has adopted this method for several years. The canvas in a sail is measured and the spars are not, so the boat is taxed only for the actual area she has in her sails, and the spars can be made sufficiently long to insure the proper setting of the sails. The restrictions are put on the light or balloon sails. The same question arises in almost any rule. The new rule, under which we are to-day building the Class "Q" boats, is productive of an abnormal sail plan. The designer is forced to produce a high, narrow-headed sail, of which I shall have more to say later. The tall, narrow plane has some very serious faults that should not be carried to the extreme they are in the Class "Q," and especially the Sonder Klasse.

DOUBLE TOPSAILS AND TOP GALLANT SAILS.

A SHIP WITH DOUBLE TOPSAILS, ON THE LONG OCEAN SWELL.

BARK WITH DOUBLE TOPSAILS.

(Copyright photographs, Lamson Studio.)

but as soon as any windward work begins the latter immediately begin to show their superiority. I contend that any boat that can show speed in reaching and running should be able to do the same in windward work, provided she is as well clothed as her antagonist.

We see much written to-day by yachting experts on the draft in American sails. We are inclined to think that too much has been written on this very point, and we are giving points to the other fellow that we had better "keep up our sleeve" for another day. I must say I am not at all in sympathy with the idea—no matter how good a fellow our opponent may prove himself to be—that we should immediately turn over to him the full working plans of our winning boat, and also present him with a suit of American sails. Why, it would be a grand idea to present to a "jolly good fellow" on the other side of the "pond" the *Reliance*, the fastest craft afloat, and ask him to challenge again!

In our work as makers of sails for some of the most famous boats afloat, we have learned many valuable points and collected much valuable data, and we propose to keep it to ourselves. It is our stock in trade; but, as I have said, we can give our friends much valuable information that will be of real value to them in the handling of their canvas.

The idea of draft in a sail does not mean that the sail should be a bag, or approach bagginess in any degree. There is a vast difference in the meaning of the two terms.

The theoretical idea of a sail being a perfect plane is carried to the extreme in all sails of English manufacture. We believe that the idea of a sail being a perfect plane, starting at the luff or mast and going in an absolutely straight line to the leach, giving a surface that allows the wind current to pass across the sail and escape at the after leach, is not correct. But if the sail can be so constructed that the wind entering into its surface strikes the sail at an angle slightly diverging from its true course or direction, it strikes the sail with a greater impulse, and should give the sail more push.

To put it in a plainer way, here is an illustration of the idea I wish to convey. Suppose the boat is laying at a mooring with sail set perfectly smooth, and is directly in the wind. If at the point of center of effort of the sail a cross should be marked on the surface of sail, and a plumb line dropped from the gaff, crossing the mark at center of effort—we are supposing the boat to be laying directly in the wind—if she be payed off on either tack so that the sail becomes filled with wind, the cross marked on the sail would immediately move forward of the plumb line. Now, we claim a sail should have

incorporated into its construction in the forward body enough fullness or freedom in its surface to accomplish the above result.

As I have already said, there is a vast difference between the terms "draft" and "bag." A sail so made that it shows only one curve, or the segment of a circle, in its surface is entirely wrong. That is "bag." "Draft," properly described, means an elongated parabolic curve, or a curve commencing in the luff or windward part of the sail next to the mast in

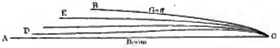


FIG. A.

a parabola, continuing into a nearly straight line to the after leach. But still further, the after part must not be too hard and flat. At its outer part it should still show some considerable freeness, so that the after edge of the sail may not in any sense show a tendency to hold at all to windward of the true ending of the elongated curve, as shown in Fig. *a;* where *A* is the boom, *B* is the gaff, *C* is the mast, *D* is one-third of distance from boom to gaff, and *E* is two-thirds of distance from boom to gaff.

The illustration is simply to give an idea of what we mean by draft, and how it is distributed in the sail. Now, the amount of draft to be put into a sail depends to a great extent on the shape and proportions of the sail, and the shape and proportions of a sail should depend to a great degree on the locality and conditions in which it is to be used. I now refer to a paper read at the Massachusetts Institute of Technology, and include with this a copy of the same as follows:

Before going into the discussion of shape and proportion of sails, one other consideration must be given, as to the different conditions under which a boat may be used. By conditions under which she is sailed I mean weather and locality, and in using the word conditions I wish it understood as referring to the strength of the winds. In our experience as sailmakers almost the first question we ask a customer is: "Where do you use this boat?" We have found that it makes a vast difference as to the location, for at the different points along our coast we find the weather conditions so entirely different as to cause us to make very different recommendations for a sail made for use in Buzzards Bay or Long Island Sound or at Marblehead. In our opinion the sail plan for a 21-footer for use at Marblehead should be quite different from one for use in Buzzards Bay.

At Marblehead the weather conditions are such that we would recommend a very high, narrow plan, while at Buzzards Bay we would recommend a lower, broader plan for the same design. The conditions at Marblehead are, on an average, light winds. Also, the wind currents are high up from the water, and what might well be called streaky currents, the wind being found in veins, a peculiar feature of this locality, especially in light winds. I have no real authority for this statement, but should judge that my statement would stand some test. At Buzzards Bay the prevailing winds are southwest, and strong and heavy, the sea breeze blowing in damp and strong. As we ship our sails to many different localities, we find it quite to our advantage to inquire into and study these conditions.

Possibly San Francisco Bay may be an interesting example of these conditions. At first it was a difficult problem with us, and, in fact, it took about two seasons for us to accomplish the best results there. The conditions there are peculiar, in that the trade wind blows directly into the harbor and generally right up the bay, taking the channel or center of the bay. Starting out from the city side of the bay, a yacht will have a soft, light wind blowing from 4 to 7 miles an hour. As she approaches the channel or center of the bay she enters the strong current of the trade wind until, reaching its center, she has a wind of from 25 to 30 miles an hour, and goes out of this as she reaches the other side of the bay. So, practically, she sails from a light wind through a strong one into another light wind, and here we find a double condition to contend with. Sails made for use in these waters are really a compromise between what we would make for the two conditions alluded to earlier. Knowing the conditions of weather under which the boat would sail, it would be a choice of either one of the plans mentioned—that is, the high, narrow plan, the low, broad plan, or a compromise between the two.

Let us consider first the important characteristics of the light-weather sail plan. In all of these plans the angle of the

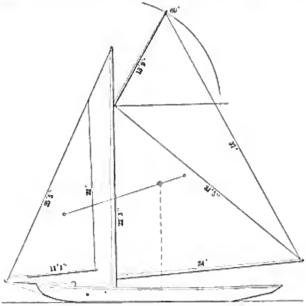


FIG. 1.

gaff or peak of the sail is a most important factor, and is deserving of the greatest consideration. We have found from experience that the high, narrow sail will not bear so high an angle of peak as the low, broad sail plan. In order to get the best results for light conditions, it of course becomes necessary as the hoist is increased to shorten the gaff, and take 65 degrees maximum and 50 degrees minimum as a basis for all peak angles. As I say, taking 65 degrees as a maximum, as the hoist is increased and the gaff is shortened, the angle of peak should be lowered. I am speaking of a restricted area.

In the present raceabout class, an angle of 60 degrees on the following dimensions of mainsail will be found to give the best results: Hoist, 22 feet 3 inches; head, 13 feet 9 inches; foot, 24 feet, and leach 37 feet; 480 square feet in the mainsail and 120 square feet in the jib. The illustration before you is what we consider one of our best 21-footer sail plans for light conditions. In the proportioning of one sail to the other, or in dividing the area into the two sails, mainsail and jib, this plan is a very excellent one, and shows the result of careful study as to the best result to be obtained in dividing the 600 square foot area. (Fig. 1.)

To make a comparison of one or two plans I will take first one of our champion 25-footers, and illustrate the point as to overpeaking the mainsail by explaining how at first this was a very unsatisfactory sail, and, by a slight alteration, was so greatly improved as to make the boat an easy championship winner. The sail as seen by myself, under almost ideal

conditions, was far from satisfactory, and had a very serious fault in that it showed entirely too much bag in the upper forward angle of the sail. If the peak was set up to the angle at which it was designed, the sail had the bad fault mentioned, and the yacht had to be kept off to allow the sail to be kept full of wind. Now, in order to lessen the bag mentioned, the peak was dropped, with the result that the gaff swung off to leeward, and then the boat would not reach as fast as she should. The correction was made by cutting down the angle of peak 6 degrees, with the result of getting an almost ideal sail. (Fig. 2.)

With the amount of area divided into the two sails of a jib and mainsail rig, care should be taken to so place the sails on the boat that one will be entirely independent of the other;

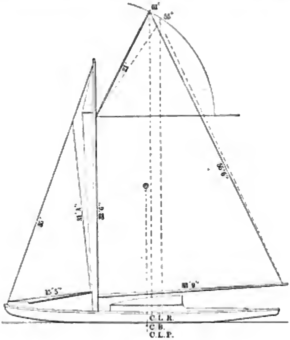


FIG. 2.

that is, it will be found of much advantage if the jib is placed far enough forward so there can be no draft of wind or air current passing from the headsail to the lee side of the mainsail. If the two sails are so close to each other that the current of wind from the jib strikes the lee side of the mainsail, it is more than likely to lift the forward part or luff of the mainsail out to windward, and, of course, that part so affected is a dead loss to the boat. The sails should be so placed that every inch of the mainsail may be doing its full work. Especially should the head of the jib be kept well away from the mast, as the upper part or the head of the jib is much nearer the mast than it is at the deck. Also, the upper part of the mainsail is at a broader angle than the boom. So you may readily see the importance of keeping the jib clear of the mainsail.

In designing headsails, this question of one sail interfering with the work of another is of great importance. In a plan where the head area is divided into two sails, this question should receive great consideration. In our older plans of boats, designed and built fifteen or twenty years ago, when the double-head rig or cutter rig first came into use, we at first had a great deal of trouble in getting satisfactory headsails, and the greater part of the trouble was from the cause I have just mentioned.

On a single-masted boat the headsails are called forestaysail and jib, but properly speaking they are really foresail and jib, as the name forestaysail should really apply to the first sail forward of the masts on a schooner. In either rig, sloop or schooner, the two sails must be so arranged as to have the least interference possible with each other. Care must be taken to keep the jib from coming too close to the forestaysail, and one way to succeed in this is to be careful not to get the points at which the two sails attach to the mast too close to each other.

The jibstay should be a very considerable support to the masthead. And the forestay, while being kept as much as possible clear of the jibstay, should not be placed so low down on the masthead that the strain of the halyard in setting the sail may be in any way likely to assist in pulling forward that part of the mast near the jaws of the gaff.

The boom should be placed high enough from the deck so that the helmsman may have a good opportunity to see out under it at almost any angle of heel. On a 21-foot raceabout, 18 inches is a convenient height, and at the taffrail 3 feet should make a good, convenient clearance, and also keep the end out of the water when running with a free wind. Now, in getting the right length of mast for a boat of this class, or any class (as this rule will invariably apply in all cases), do not lose sight of one very important point—the lower peak halyard block should never be lower than a level line drawn through the center of the gaff. This will always insure your being able to hold the peak up to its proper position. The lower peak angle will, of course, have a greater tendency to thrust or push against the mast at the jaw of the gaff than the higher angle. Should this occur it can be remedied by a strut and stay on the forward side of the mast, which has been adopted on almost all classes of racing yachts to-day, from the 15-footer to the 90-footer, and with this arrangement of rigging the spars can be made much lighter in weight.

The jib on a 21-footer is of the following dimensions: Luff, 31 feet 5 inches; leach, 22 feet, and foot, 11 feet 3 inches; the intersection of the foot and leach being the point nearest to the mast, this distance on the plan I am discussing at this point being 2 feet 4 inches and the head 3 feet from the mast; so you may readily see the care taken to prevent the jib throwing any wind under the lee side of the mainsail. Of course we would not carry this out on a larger boat, as it would not be practical on a sloop or schooner, especially one of size. Possibly I might have covered this point in fewer words by saying, "in planning your headsails do not make them lap one over the other any more than necessary." I firmly believe that the best jib is one that does not lap by the forestay at all. In headsails the foot should be cut high, the forestaysail well up and clear from the deck. Also, the jib should have a high clew (this is the point where the leach and foot intersect). The nearer a jib on leach and foot approaches the same dimensions, the more perfect will be the sail, and especially is this true of jibtopsails. While all of our knowledge on this matter has been gained in a practical way, it has been almost the work of a lifetime to educate yachtsmen and designers to these facts. In making plans for schooner rigs, it has become almost a custom to place the mainmast at about the midship-section, which on most of the modern plans will be found near the center of the waterline. The foremast will come nearly half way from the mainmast to the stem of the vessel, and on almost all of our schooner plans I find the center of effort will be found just about at the forward side of the mainmast, and the center of lateral resistance from 18 inches to 2 feet aft of this.

The custom of making the mainmast longer than the foremast I also find falling into disuse, and on almost all of our new plans you will see the two masts of about the same height, with some little difference in lengths of the topmasts. The rigging plan should also be a part of the sail plan, as it is

most important that the mast and other spars be held as straight and firmly as it is possible to make them. As soon as a mast or boom or gaff begins to bend or buckle out of shape, just so soon is your sail out of shape and losing its efficiency. The shrouds should be placed, one from the top of the masthead leading forward of a center line of the mast to hold the masthead from springing back, and one from a point as near as possible to the jaw of the gaff, leading aft to hold against the forward thrust of the jaw of the gaff. The jibstay and upper shroud should hold the mast from coming aft. The lower shroud and runner should hold the mast from coming forward.

Another important point in relation to your sails is to properly trim them. Knowing after a trial at about what angle the main boom should be, great care should be taken to get the head sheets so arranged that they will work to the best advantage with the mainsail. The head sheets should not be too broad or too flat, and in planning them care should be taken that their shape and proportions are so arranged as to have them sheet at convenient places on deck, or, in the case of the jib, on the rail. Many a boat has never shown her best speed for the reason that her headsails were improperly shaped, or not trimmed at the right angle for their best work with the mainsail.

Now, in making a suit of racing sails it is our custom, starting with the sail plan of the yacht, to make a cutting plan of each sail. We cut all of our sails on the floor. We first make a plan of the sail, drawing in the curves or roaches, as the sailmaker would term them, for each side of the sail. It would be impossible to cut a sail by laying down simply a set of straight lines. The body of the sail is not a flat plane. Consequently it becomes necessary to give it form by laying outside of these straight lines some curves whereby the body of the sail may have some draft or curved lines that make a perfect sail. We have from our data established a scale of percentages that we use to give us the amount of curve we shall put into the foot or boom part of the sail, also in the mast or luff, head or gaff and leach. These curves, properly determined, are put on the plan, and the same is laid down on the loft floor. The cloths are carefully cut to these lines, great care being used to know that the same amount of tension is applied to each cloth. Each cloth is pinned to the floor until all are cut. Next comes the careful marking of each seam. The cloths are laid one on each preceding one and marked at every foot for the machine or hand sewer, and the foreman makes it his business to see that the marked spaces are carefully matched in the sewing, whether sewed by machine or hand.

After the sail is carefully sewed together it is again spread out on the floor, and each seam is carefully ironed out so that it may come to the original dimensions. In hand-made sails the greatest care is taken in this detail, as it occurs in hand sewing that a certain amount is taken up in sewing the sail. The seams, when the sail is spread out on the floor, are carefully ironed out as smoothly as possible. The finished dimensions are then laid down on the sail, and the lines of roach or curve to be put into the sail are marked. The part that is outside of these dimensions is what the sailmaker would call the "tabling." Outside of the sail loft it would be called a hem. Herein lies a point about which we are very particular. The strips or tablings are laid back on to the sail to make the hem or strengthening pieces around the edge of the sail where the rope will be sewed on. It is not our custom, as with some sailmakers, to put on the edge of the sail straight bands of duck for tablings, as we have found from experience that these bands will not stretch evenly with the sail, and so we provide bands cut from the sail as described, so that each thread in the band may lay parallel with the sail under it, insuring an even stretch to both parts. These tablings are carefully basted to the sail, and sewed either by hand or machine, as the case may be. All of our lighter sails are made by machine in these days, and our heavier sails are made by hand. We do many things on the hand-made sail that can be accomplished only by the cunning hand of the skilled workman.

After the sail has been tabled or hemmed, the eyelets are inserted by which it is bent to boom, gaff and mast hoops. It is then turned over to the roper, and herein lies the finest part of the whole business, and the success and future of the sail. Only the very best and most skilful workmen are employed on this part of the work. He must be a man of good judgment, and able by his skill as a workman to put into his work the idea of the master. The ropes are carefully stretched and marked at spaces of 1 foot, like marks being placed on the sail, and where there is more rope than canvas wanted for a certain space, or the opposite, as the case may be, the workman shall be able by his skill to sew the two together to the satisfaction of the foreman.

The bolt ropes vary on the different sides of the sail as to size, and how they are roped on to the sails. Years of experience have taught us that the best bolt rope for yacht sails is the imported Russia hemp bolt rope, made by Hoth, of St. Petersburg, Russia.

All duck or canvas will stretch. The amount of stretch depends on the material or fiber of which it is woven. Up to about the year 1840, or thereabouts, all sails had been made of flax. If I am not greatly in error, the first sail made of cotton was about the year 1832, and the first cotton to be used in sails was worked up in New York city. The flax duck used up to that period was very similar to the flax in use to-day. Most of this material was made in Holland, and was known as Holland duck. It is used in England and on the continent to-day for sails for ships and coasting vessels. Up to the coming of the yacht *Thistle*, the English sailmakers had used flax duck for their racing sails, although of a quality much superior to that used for commercial purposes. In fact, it is in use to-day in England for cruising yachts.

The great advantage of cotton fiber over flax is that it does not stretch so much, and will not come and go to such an extent with the changes of the weather; that is, when subject to dry, hot winds, will give or stretch but very little as compared with flax. With the adoption of cotton in the making of canvas for sails, there was also put into practice in this country the lacing of sails to the boom. As I have said, any piece of canvas will stretch, one principal reason being that duck is constructed on what the weaver calls a plain weave or basket weave. It is made by two sets of yarns, one known as the warp, or those threads which form the length of the piece of goods, the other set being the weft or filling thread. In weaving a piece of goods, the warp is comprised of two sets of threads, the upper and lower. The filling or weft passes between the two warp threads. The warp passing up and down on the weft or filling has some considerable corrugation put into its length, as can be seen by Fig. *b*, which shows the form of a piece of canvas if cut lengthwise, the circles showing as the ends of the wefts or filling, and the warps showing as corrugated.

FIG. B.

In weaving a piece of ordinary canvas, the weaver would make an allowance of nearly 25 percent for take-up in the warp; that is, if he wishes to make a piece of canvas 100 yards long, he would require 125 yards of warp thread. In the weft or filling, the thread laying nearly straight in the goods, the take-up would be about 10 percent. Before being put into the loom, a certain amount of twist is put into both of these

threads, as each is comprised of a multiple of smaller single yarns. This is called doubling, and as the number of doublings, so is the number of twists per inch. This is a mathematical problem, and is worked out by the weaver on that principle. This twist put into the yarn gives it a certain amount of spiral. The more twist or spiral it contains, up to a certain point, the more will it stretch. Take a number of small threads and lay them parallel. Also take the same number of threads and twist them up a number of times or twists, and you can easily see that the twisted threads will give or stretch more than the straight ones. The twist is necessary to give the required strength to the fabric.

If we take a piece of duck or canvas of a certain length and subject it to a strain, it will, if pulled lengthwise, stretch, for the reason that the corrugation caused by the weaving process, and also from the spiral caused by the twisting of the single yarns together, give and stretch; but, while it stretches in length, it will, at the same time, become narrower. As it goes out lengthwise, it will come in crosswise.

As all duck will stretch more lengthwise than crosswise, we have of late years adopted a method of making sails which we term crosscut. Formerly it was our custom to arrange the cloths parallel with the after leach, and we had to make considerable allowance for stretch. In crosscut sails—or those sails which have the cloths or seams arranged at a right angle to the after leach of sail—we have put that part of the goods having the least tendency to stretch to the line of the greatest strain. The greatest strain to which a sail is subject is from its clew, or that corner of the sail attached to the outer end of boom, on a line drawn from that point to the center of effort in the sail. That we have a smaller amount of stretch to contend with in crosscut sails than in the old style of cloths arranged parallel to the after leach is a fact, and makes the problem a much easier one for the sailmaker.

(To be Continued.)

THE HEATING AND VENTILATING OF SHIPS.

BY SYDNEY F. WALKER, M. I. E. E.

HEATING BY WARMING THE AIR ENTERING THE ROOM.

The tendency of modern heating appliances, both on shore and afloat, is to warm each room individually, each cabin, saloon, corridor, etc., by warming the air entering the room, or a certain portion of it. As will be explained in dealing with ventilation, the latest application of the system combines heating and ventilating. The ventilating air current is made use of to warm the room by being itself warmed before it enters the room, and similarly the air may be cooled before entering the room, and so keep the temperature down.

There are several methods of warming the air entering the room in which the appliances that have been described are made use of, with slight modifications that will be explained, and in addition to these the whole of the air is warmed by special apparatus, as described above. One of the methods that have been developed on shore is by causing a certain quantity of oil to be heated by the stove, or fire grate, as explained below, and to be delivered into the room at a higher temperature than rules outside.

SPECIAL AIR-HEATING STOVES.

On shore a number of stoves have been developed that are doing very good work in hospitals and other institutions, in which a certain quantity of air is warmed before it enters the room by being passed over a hot surface, specially arranged for it, in the grate or stove with which the room is heated in the ordinary way. The arrangement of the grate is shown in section in Fig. 48, and a complete stove is shown in Fig. 49. This is the form made by George Wright & Company, Rotherham. (See next page.)

It will be seen that in place of the fireplace extending right to the back of the chimney, there is a space behind that devoted to the burning fuel within the chimney proper, and that the hot gases, smoke, etc., from the burning fuel are taken up through an iron flue inside the chimney proper instead of being delivered straight into it from the fireplace. Air is led between the flue and the chimney space from the outside, usually by a duct leading from the outside air through one of the outside walls in the neighborhood, where a grating is provided that can be arranged to regulate the quantity of air entering. The cold air from outside passes through the duct over the hot surface of the back of the fireplace and that of the flue above, and is delivered into the room through gratings provided for it at the level of the usual chimney breast in front, and sometimes also at the sides.

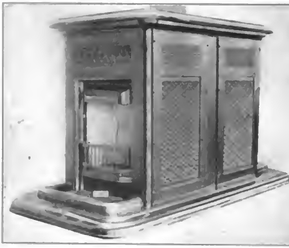


FIG. 51.—WARM AIR VENTILATING GRATES (GEO. WRIGHT & CO.)

In the large hospital stove shown in Fig. 51 the air is delivered from the front, sometimes the top, and always the sides, and it is a common thing for hospital wards to be warmed by a stove of this kind at the end farthest from the door, and one or more pairs of similar stoves standing back to back in the middle of the ward, at a certain distance from the door. Stoves of this kind are made for smaller rooms as well as for the large rooms of which hospital wards usually consist, and it appears to the writer that they could be very well adapted for heating the saloons, mess rooms, etc., on board ship, the air to be warmed being taken from above the upper deck by a ventilating arrangement, properly protected in the usual way, and brought down at a little distance from the stove and then run in under the deck to the air space described.

A modification of the air-heating stove, which has been used in a school, but which is somewhat crude, consists of a stove of the usual slow-burning type, standing near the middle of the school room, with a chimney carried vertically to within a few feet of the ceiling, and then carried to the outer wall at an angle a little above the horizontal, the chimney being continued outside the outer wall in the usual way. The nearly horizontal portion of the flue has a second cylinder surrounding it, into which air is brought from outside at the point where the flue emerges, and the air is warmed by its passage through the annular space between the flue and the surrounding cylinder, and is delivered to the room above the stove, warmed to a certain temperature.

The arrangement of the air-heating stoves mentioned for

hospitals is a great favorite with some of the superintendents, because they say that the firegrate gives the ward a certain cheerfulness, and the matter of heating the air is fully provided for by the arrangement described. The radiation from the dancing flames of the ordinary cheerful fire has also an important bearing upon the subject. The yellow flames that the Anglo-Saxon so likes to see give out light rays principally; but, according to the latest experiments, the light rays are converted into heat rays after passing through the skin and warm the body, while the red rays and the dark or invisible heat rays do not pass through the skin, and have therefore no useful effect, unless they are made to impinge upon something that will absorb them, such as the furniture of the room. The hospital superintendents referred to find that the ward fires have a good effect, and under the above reasoning they are scientifically correct.

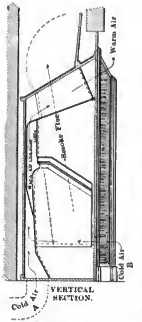


FIG. 48.—AIR-HEATING FIRE GRATE.

FIG. 49.—FRONT OF AIR-HEATING FIRE GRATE. WARM AIR ISSUES THROUGH REGISTER AT TOP.

FIG. 50.—BACK VIEW OF AIR-HEATING FIRE GRATE.

HEATING THE AIR BY MEANS OF STEAM, HOT WATER AND ELECTRIC RADIATORS.

The next method of heating the air is by causing it to pass over the radiators that have been described, on its way into the room. It will be understood that there are two methods of arranging radiators in any room that is to be heated. One is by fixing the radiator somewhere near the middle of the room, and allowing the air of the room to be gradually warmed up by the convection currents that are set up and by the radiation from the stove. This method gives the engineer very little control over the temperature of the room, or of any part of the room, at any moment. If a door, for instance, is left open, and the passage or corridor into which it opens contains cold air, the heating within the room will probably be very poor, even with a considerable number of heating appliances, except in their immediate neighborhood and on the opposite side to that from which the draft is coming. The case is very similar to that of the coal fire with an open door or a very drafty door.

The other method is to place the radiators, or other heating appliances, in the path of the air that is entering the room and that is to be used more or less directly for ventilation. Where ventilation is effected entirely by windows, by open door, or, as is so frequent, by loosely fitting doors, it is practically impossible to employ radiators in this way. But where doors are properly fitted, and where a supply of air is taken directly from outside of the room, it can always be warmed by passing it over the surface of a radiator. On shore the usual method is to fix the radiators close to the outer walls of the building; under a window is a favorite position. Holes are made in the wall, fitted with gratings of various forms, arranged so that the quantity of air passing through them can be regulated; and the air entering the room through these gratings is caused to pass over the surface of the radiator on its way, and therefore attains a certain temperature before it mingles with the air already in the room.

In a modification of this arrangement, the radiator is specially fitted, as shown in Fig. 52, with a plate on the inner side of the radiator tubes, which acts as a baffle to the air; and the air is obliged to pass over the full vertical and horizontal length of the radiator, and issues from it at a certain height above the floor. It is given a certain upward tendency, which causes it to mingle better with the air in the room, and produces very good heating effects. The question of the exit of the air in these cases belongs to the matter of ventilation and will be dealt with fully in that section. It may be mentioned here that the vitiated air of the room is usually carried off by the chimney, which still forms a part of the equipment of the modern house that is fitted with radiators, a grate also being provided that can be used in case of emergency.

On board ship, the equivalent of this would be similar to the arrangement suggested for the air-heating stoves. Ventilators bringing air from the topmost deck, or from the outside atmosphere, wherever it can be obtained without danger, would carry it by means of pipes down into the saloons, cabins, corridors, etc., and the air would then be directed over the radiators, in the manner described, and thence out into the rooms. The difficulty involved in these arrangements is, of course, that of providing the number of ventilators that would be necessary, since each radiator would require its own special ventilator, to provide its own supply of air, though it might possibly be arranged for one ventilator to supply air to two or three radiators. Unfortunately, under present conditions of seagoing ships, it does not seem practicable to employ the same arrangement for the supply of air as is used on shore, viz., for air to come in through the ship's side; though if valves can be arranged that will allow air to come in, and not water, when the ship is in a seaway, that portion of the problem would be solved. As will be explained in dealing with

ventilation, something of the kind has been done and may possibly be extended.

The above remarks with regard to heating the air, by passing it over the surfaces of radiators, apply equally to steam and hot water, and to electrically heated radiators, and that, no matter whether the electric heating elements are of the luminous or non-luminous form. In fact, the majority of modern electrical convectors are arranged on those lines. The air of the room is heated by passing through the radiator, entering it at the bottom, passing upwards over the heating elements, whether they are lamps or resistance substances, and issues from the top of the apparatus at a considerably higher temperature. Fig. 53, taken from the catalogue of Messrs. O. C. Hawkes, Ltd., shows the idea. The air issues from the top of the radiator at a high temperature and gradually cools as it mingles with the air of the room beyond, raising the temperature of the latter air in the process.

It may be mentioned that one of the most successful forms

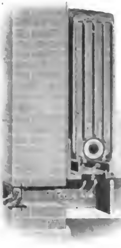


FIG. 52.—RADIATOR ON SHORE HEATING AIR DRAWN FROM OUTSIDE. NATIONAL RADIATOR COMPANY.

of gas-heated radiators, an American invention, operates on these lines. It stands out in the room in any convenient position, and air enters it from below, the products of combustion and warmed air issuing from below a plate on the top and mingling with the air of the room.

AIR-HEATING APPARATUS, PURE AND SIMPLE.

The air heating apparatus, pure and simple, really belongs to the domain of ventilation. In it the air for a whole building on shore is taken hold of, is cleaned in the case of towns where the atmosphere is foul, such as London and the manufacturing towns of the United Kingdom, and is warmed by passing over steam pipes, or cooled by passing over pipes containing either water or a solution of cooled brine, and delivered into the rooms to be warmed or to be cooled by ducts arranged for the purpose. The vitiated air is led away out of the rooms by means of other ducts, and is carried away to the outer atmosphere.

On shore, the usual method is to build a shaft on one side of the building, sometimes in the middle of the building, and carried up as high as convenient, and to a point where the air is as pure as it can be obtained. At the bottom of the shaft an entrance is made to the building by means of a large duct leading through a hole in the wall, and in this hole and duct are fixed the cleaning arrangements and a fan. On the other side of the hole, ducts lead to the different portions of the building, these ducts branching off to different sections of each portion of the building, and becoming smaller and smaller as the cubical space they have to supply becomes less.

The hole in the wall is usually occupied by the fan, and the cleaning apparatus is fixed on the outside of the fan, and also heating apparatus for the very cold winter months. A favorite form of cleaning apparatus on shore is a kaiar screen, stretched in front of the entrance to the building, and having

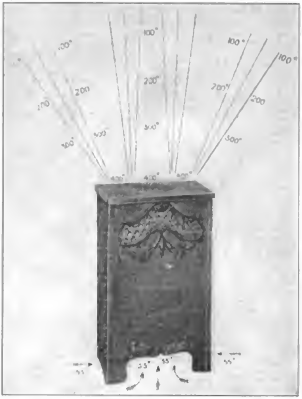


FIG. 53.—DIAGRAM SHOWING ACTION OF STOVE AS AIR-HEATER.

a stream of water constantly pouring over it, the screen being further cleaned by periodical flushes from a pipe above it, from which also the other cleaning water proceeds.

For shipboard work, particularly the modern ship that is divided up into so many watertight compartments, the problem is complicated by the fact that the deck has to take the place of the side of the building. Any air that is taken for ventilating or heating purposes must come from the deck, and any vitiated air that is expelled must be carried up to the deck. Any heating or ventilating appliance must enable the air to be carried separately into each compartment, and separately taken out of it, back to the deck. Though in the large, modern liners the deck is fairly large, it is not unlimited, and the provision of so many pieces of apparatus leading to different compartments and leading from them is sometimes a trouble, seeing that space has to be found for so many other things, such as boats, skylights, winches, etc.

On the other hand, a ship at sea has one very great advantage over a building on shore, especially a building standing in the middle of a smoky town. The air at sea is as pure as it is possible to obtain, and therefore, provided that reasonable care is taken to prevent the "stokers" from the chimney finding their way into the air inlets, and to keep the air inlets clear of outlets from lavatories, etc., any air inlet arranged on

a deck that is open to the atmosphere must provide absolutely pure air, and air fairly well charged with ozone. The passage of the ship through the water also necessarily carries off the vitiated air, leaving it behind, and, providing that care is taken that the vitiated air outlets are not placed, with reference to the air inlets, so that under any conditions of wind the vitiated air can find its way into the air inlet, the problem of inlet and outlet, subject to the question of space, is a very simple one.

Practically all that is required for warming the air supplying any part of the ship, say saloons, staterooms, officers' quarters, etc., are ducts leading from inlet apparatus on deck to the different parts of the ship to be warmed, and with a grid of steam pipes arranged in the path of the air to be

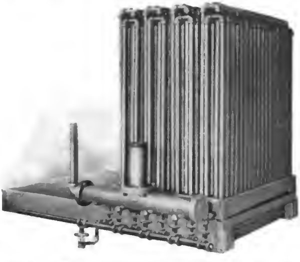


FIG. 54.—AMERICAN BLOWER COMPANY'S AIR-HEATER ON FERRY BOAT.

warmed (the grid being provided with a regulating valve, so that the pressure and temperature of the steam can be regulated at will), and some method of driving the air down below. Modern practice on board ship has settled down to the use of fans, and they are used sometimes for driving the air down below, sometimes for exhausting the vitiated air from below, and sometimes for both purposes.

The following is an account of some work done by the American Blower Company, of Detroit, Mich., on board the ferryboats of the Pennsylvania Railroad Company at New York. The air is heated by a bank of steam coils, on the lines of those shown in Fig. 54, which is fixed in the hold below the main deck. Fresh air is brought from above the main deck by means of a shaft, and is drawn over the steam coils by means of a fan on the other side of them, and when warmed is forced through a system of galvanized iron ducts into the passenger cabins, saloons, etc. The air enters the cabins, etc., through openings 3 or 4 inches in diameter, closed by louvre gratings, arranged for controlling the supply of air in the usual way. Owing to the limited space, the ducts were obliged to be somewhat small, and the velocity of the air consequently rather high. The heating apparatus was arranged in sections, so that the ducts leading to the different parts of the ship might be separately controlled. Other firms have arranged apparatus on something the same lines.

INLETS AND OUTLETS FOR THE AIR.

The cowl that was introduced a good many years ago for admitting air to spaces below deck has been superseded by short, vertical pipes, fitted with protecting hoods, the air passing up under the hood and down the vertical pipe, instead of passing into the mouth of the cowl, as was usual in older times. The same arrangement answers equally well for an outlet for the vitiated air. The principal requirements for inlets and outlets are that they shall be very strong; shall be firmly secured to the deck; shall not project above the deck more than is necessary to obtain a proper supply of air; shall not be liable to be easily carried away by a heavy sea, and shall not be in the path of any object that may break loose in a heavy seaway. Cases are on record in which the old form of cowl has been a serious danger to a ship.

One in particular that was mentioned at a discussion upon ventilation, at the Institution of Naval Architects, was that of a ship which was fitted with cowls, and which shipped a very heavy sea in a storm, the sea breaking in one of the hatchways on the fore deck, and the ship commencing to settle by the head. The hatchway was covered in a comparatively short time with tarpaulins and the pumps got to work, but it was found that the ship was still settling by the head, and eventually it was discovered that the fore trysail boom had carried away one of the cowls, and in the darkness (it was at 4 A. M.) this had not been noticed. The ship had a well-deck, and the sea had left a large quantity of water upon it, which was finding its way down through the hole left by the cowl.

(To be Continued.)

AFT END OF CRADLE WHEN HAULED UP TO HIGHEST POSITION.

A 2000-Ton Railway Dry-Dock.

The accompanying illustrations show one of the latest types of the larger capacities of railway dry-docks recently built by the H. I. Crandall & Son Company, of East Boston, Mass. This was constructed for the Richard T. Green Company at their repair and shipyard plant, Chelsea, Mass. The capacity of the dock is 2,000 tons dead weight, length over all 250 feet by 60 feet wide between the docking platforms. It is designed with especial regard to docking quickly and easily such craft as heavy dredges and large scows.

The cradle is built of timber, with the deck 1 foot higher than the surrounding water when hauled up to its highest position, and is fitted with twenty-six patent releasing bilge blocks, operated from a platform on each side by hand winches and chains. The keel blocks are of oak and spaced 6 feet between centers. The track rests on pile foundations, and is laid to a grade of 1 to 12. Including the machinery foundation, it extends the short distance of 455 feet from the street to the harbor line. The fact of successfully building, in this contracted space, a dry-dock of the railway type for vessels up

VIEW OF MACHINERY AND HAULING CHAINS—FORWARD END.

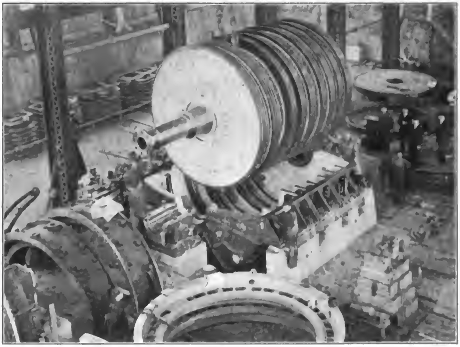
to 260 feet length of keel, and drawing 16 feet mean, when light, shows its great adaptability under difficult conditions.

The raising and lowering of the cradle is accomplished by four heavy chains of special long-link type, attached to the forward part of the cradle runner through equalizing gear, thereby absolutely preventing unequal loading of the individual chains. These chains pass over cast-steel sprocket wheels, made to revolve by a train of machine-molded gears, operated in turn by a double-cylinder reversing engine; all parts are securely attached to heavy foundations. The time required for hauling out vessels, after centering them in the cradle, is 20 to 30 minutes on the slow speed, and 15 to 20 minutes on the fast; the latter being used for vessels of the lighter types.

The construction of the mammoth Hamburg-American liner *Europa*, in the yard of Harland & Wolff, Belfast, has been temporarily abandoned.

A Large Marine Turbine.

The photograph shows the lifting of a rotor from the motor casing of one of two 12-foot 7-stage Curtis reversible steam turbines under construction by the Fore River Shipbuilding Company, Quincy, Mass., for the Japanese government. These two turbines are to develop a collective brake or shaft horsepower of 24,000, with a considerable margin for overload capacity, and are to be installed in an armored cruiser designed for a speed of 23 knots. They were shipped early in April to Kure, Japan, by way of the Suez Canal.



THE ROTOR OF A 12,000-HORSEPOWER CURTIS MARINE TURBINE SUSPENDED OVER ITS LOWER CASING.

Transportation by Water.

The United States Census Bureau has just made public a report for the year 1906 covering transportation by water for all American vessels of 5 tons and upwards. Comparison is made with the census of 1889 in many particulars, and a very great growth is shown. The figures for the recent year show a total of 37,321 vessels with a gross tonnage of 12,893,429 and a value of $507,973,121 (£104,381,602). The gross income was $294,854,532 (£60,588,616), and wages to the amount of $71,636,521 (£14,720,337) were paid to 140,929 employees. The number of passengers carried was 366,825,663, while the net tonnage (2,000 pounds each) of freight carried was 265,546,845. As compared with 1889 the gross tonnage had increased 54 percent; the value of vessels, 145 percent; the gross income, 82 percent; the wages, 73 percent; the number of employees, 24 percent; the number of passengers, 84 percent, and the freight tonnage, 104 percent.

The vessels were divided into three main classes, steam and gasoline (petrol) accounting for 9,927 vessels and 4,059,521 tons; the sailing vessels numbered 7,131, with 1,704,277 gross tons; unrigged vessels, largely in the nature of canal boats and barges, numbered 20,263, with a gross tonnage of 7,129,631. Of the steam vessels, 3,615 with a tonnage of 3,411,588 were devoted to freight and passenger service; 3,079 of 261,375 gross tons were tugs and towboats; 536 of 261,073 tons were

ferryboats; 2,176 of 82,275 tons were steam and power yachts; while the small balance is in scattering classification. Of the total steam and power vessels, those operating on the Atlantic coast and Gulf of Mexico numbered 5,413, with 1,457,894 gross tons. On the Great Lakes, including the St. Lawrence river, are 1,676 vessels and 1,915,786 tons. The Pacific coast, including Alaska, accounts for 1,066 vessels and 518,107 tons, while the Mississippi river, its tributaries and all other inland waters take up the balance.

Of the sailing vessels, 5,181, covering 1,672,862 tons, are devoted to carrying passengers and freight; and 1,594 vessels of 24,155 tons are yachts. Of the total, 5,920 sailing vessels, aggregating 1,132,905 tons, operate on the Atlantic coast and Gulf of Mexico, this being a decrease of more than 12 percent in tonnage in seventeen years. The tonnage on the Pacific is 305,283, while the Great Lakes and St. Lawrence river account for 265,571 tons.

line propelled vessels number 3,155, of 50,998 tons and 73,204 horsepower. Screw propellers are fitted to 2,785 of these vessels; stern wheels to 351, and sidewheels to 19. The seven electric propelled vessels all have screw propellers, their gross tonnage being 92 and horsepower 88.

Of the total vessels listed the merchant marine includes the registered, enrolled and licensed sail and steam vessels, including fishing vessels. These aggregate 25,006 in number and 6,674,969 gross tons. Of this total, 9,500 are steamers of 3,975,287 tons, and 15,506 are sailing vessels of 2,699,682 tons. The tonnage employed in the foreign and coastwise trade in 1906 aggregated 6,602,510 tons, of which 928,466 tons (14 percent) were engaged in foreign trade and 5,674,044 tons (86 percent) in coastwise trade.

The report includes a large amount of other information in detail, including traffic through the St. Mary's Falls (Sault Ste. Marie) Canal, which is placed in 1906 at 41,098,324 net

LAUNCHING OF THE JAPANESE STEAMER HIRAFU MARU AT DUMBARTON.

Unrigged vessels include 2,237 canal boats of 303,581 tons, and 18,026 barges and other vessels aggregating 6,826,050 tons. On the Atlantic coast are 8,699 of these vessels, aggregating 2,260,622 tons. On the Mississippi river and its tributaries are 8,187 vessels, aggregating 4,265,740 tons. Of the ferryboats, 152 of 129,690 tons operate in the harbor of New York, and carried during the year 208,684,123 passengers. This is 63.1 percent of the 330,737,639 passengers carried by all ferryboats.

Of the total of all types of vessels, 1,979 of 3,276,723 tons are constructed of iron and steel; 35,247 vessels of 9,581,348 tons of wood; while the balance are of composite construction. The wooden vessels include canal boats and barges to the number of 20,077 and 6,991,233 tons. The iron and steel vessels include 1,674 steamers aggregating 2,916,517 tons. Wooden steamers account for 1,119,459 tons, and wooden sailing vessels for 1,470,656 tons. Both these latter figures have decreased since 1889.

The average size of all vessels was 345 tons in 1906 and 274 tons in 1889. Iron and steel steamers averaged (in 1906) 1,742 tons; iron and steel sailing vessels, 1,740 tons; iron and steel steam freight and passenger vessels, 2,889 tons.

The number of vessels propelled by steam is given as 6,765, with a gross tonnage of 4,008,431 tons, and 3,378,453 horsepower. Of these vessels, 5,160 have screw propellers; 1,055 have stern wheels; 543 have sidewheels, and the seven others have various modes of propulsion, including hydraulic. Gaso-

tons, as compared with 13,443,392 net tons for the Suez Canal, and 5,796,949 net tons for the Kaiser Wilhelm Canal. The canal on the Great Lakes is thus seen to have passed more than double the tonnage of the other two combined, in spite of the fact that ice closes the canal absolutely during about four months of the year. The freight shipped by water during the year 1906 aggregated, as above stated, 265,546,845 net tons (2,000 pounds). The largest single item was coal, which amounted to 49,109,605 tons. This was well distributed over the Atlantic coast, Great Lakes and Mississippi basin. The next item is iron ore, 41,524,102 net tons, of which more than 99 percent belonged to the Great Lakes. There were 30,029,515 barrels of petroleum shipped, of which more than half belonged to the Atlantic coast, and 10,929,939 barrels to the Pacific coast.

International Congress of Navigation.—On the 31st of May there will be opened in St. Petersburg the eleventh International Congress of Navigation, which will be in session until the 8th of June. This Congress has had sessions every year or two since 1885, and is devoted to a discussion of various matters affecting navigation and shipping generally. The program involves consideration of both internal and oversea shipping, with an exposition of designs, plans, charts, models, etc., relating to ocean and river navigation. The sessions will be held in the Conservatory of Music.

Japan's First Turbine Steamer.

BY BENJAMIN TAYLOR.

The first turbine steamer for the mercantile marine of Japan has been built by William Denny & Brothers, Dumbarton. The steel turbine steamer *Hirafu Maru* was the first of two vessels ordered by the Japanese States Railway for special service in the Tsugaru Straits. The launch was noteworthy as marking the introduction of the turbine to Japan, and also because the ceremony was purely Japanese. The stem of the vessel was covered by a profusion of ribbons and flags, and the draping of the launching platform showed a mass of gay coloring. As soon as the vessel began to move, Madam Yamanouchi, wife of Admiral Yamanouchi, wearing the dress of the Japanese court, loosened a cord at the bows, which liberated two white doves from a covering of silk, and at the same time produced a shower of confetti, which fell upon the party on the platform beneath the vessel's bows.

The ship has a length of 280 feet, breadth 35 feet, and depth 21 feet 6 inches. She has been built under special survey of Lloyd's register, and in accordance with the requirements of the British Board of Trade and of the Teishinsho rules. The turbine machinery, which is supplied by Denny & Brothers, was designed to maintain a mean speed of 18 knots. On trial in the Firth of Clyde the speed obtained was 19.08 knots.

There is accommodation for first, second and third class passengers. The first class passengers are located in a deck house on the awning deck. Large cabins, having Pullman berths, are provided for ladies and gentlemen, in addition to the ordinary staterooms, and a special stateroom on the boat deck. The first class dining saloon is designed in the Louis XVI. style, and has a very high roof, the upper paneling of which is divided in leaded glass panels representing ancient shipping and other marine subjects. The ceiling, which is tastefully paneled like the rest of the apartment, is finished in white and gold. The sideboards and doors are of same design, the latter having the company's crest worked in leaded glass. The main vestibule is framed in light oak, dull polished. The second class passengers are located in a deck house abaft the boilers, both classes having sheltered promenades underneath the boat deck, in addition to which the first class passengers have a promenade on the boat deck itself. The third class passengers are accommodated in Japanese style at the after end of the main deck. Forward of this is accommodation for officers and engineers and the crew.

A large room is provided for mails, with suitable accommodation for the mail officers. Ample bathing accommodation is provided for all classes, as customary in Japanese vessels. The firemen and cooks, etc., are accommodated on the lower deck, which is fitted in the forward hold. Provision is made for a limited amount of cargo in the main and after holds.

The vessel is fitted with a balanced rudder of the builders' special type, actuated by a steam and hand steering gear, controlled from the flying bridge. The anchors, which are of the stockless pattern, are worked by powerful steam windlass, while a warping winch aft enables the vessel to be easily handled in harbor.

THE HIRAFU MARU ON TRIAL TRIP, ACHIEVING A MEAN SPEED OF 19.08 KNOTS.

Institution of Naval Architects.

The spring meeting of the institution covered three days, April 8, 9 and 10. Fifteen papers were presented, many of them of unusual interest. The complete list follows:

Unsinkable and Uncapsizable Ships of the Goulaeff Form and System of Construction, by Gen. E. E. Goulaeff, F. R. S., N. A.

Modern Armor and Its Attack, by Capt. T. J. Tresidder, C. M. G.

Modern Torpedo Boats and Destroyers, by J. I. Thornycroft.

The Combination System of Reciprocating Engines and Steam Turbines, by Hon. C. A. Parsons, C. B., F. R. S., D.Sc., M. A., and R. Walker.

Speed Trials and Service Performance of the Cunard Steamer Lusitania, by Thomas Bell.

A New System of Ship Construction, by J. W. Isherwood.

The Heating of Modern Ocean Liners, by W. C. Wallace.

The Influence of Air on Vacuum in Surface Condensers, by D. B. Morison.

Note on the Use of Superheated Steam with Marine Engines, by M. Félix Godard.

Results of Further Screw Propeller Experiments, by R. E. Froude, F. R. S.

An Analysis of the Resistance of Ships, by Prof. William Hovgaard.

A New Method of Research Work on Fluid Resistance and Ship Propulsion, by Herr H. Wellenkamp, I. G. N.

Two Notes on Ship Calculations, by W. S. Abell, R. C. N. C.

Factors of Safety in Marine Engineering, by Prof. J. O. Arnold.

The Modern Developments of the Mariner's Compass, by J. C. Dobbie.

INTERNATIONAL MARINE ENGINEERING

Published Monthly at

17 Battery Place New York

By MARINE ENGINEERING, INCORPORATED

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President

E. L. SUMNER, Secretary

and at

Christopher St., Finsbury Square, London, E. C.

E. J. P. BENN, Director and Publisher

SIDNEY GRAVES KOON, Editor

Branch Offices { Philadelphia, Machinery Dept., The Bourse, S. W. Annex. Boston, 170 Summer St., S. I. Carpenter.

The edition of this issue comprises 6,000 copies. We have no free list and accept no return copies.

Construction Details.

About a year ago we obtained, through the courtesy of a correspondent, a large number of prints showing details of construction of various important features of both warships and merchant vessels. These include in the main such items as rudders, stern frames, spectacle frames and propeller struts, details of rams, bilge keels, steering gear and hawse pipes. While they represent practice of a somewhat restricted locality—the Pacific coast of the United States—yet they are up to date, and are of great interest because of the wealth of detail involved, and of the fact that it is often difficult, if not impossible, to obtain such items in connection with the description of a new ship.

Particularly difficult is it to obtain accurate drawings of this sort, and, for this reason, we feel justified in presenting the material in as much detail as possible. It is being divided up into three or four sections, the first of which, published this month, covers four typical rudders, three being on warships and the other on a large merchantman.

Shipbuilding.

Lloyd's reports indicate a decided decrease in the amount of tonnage under construction in British yards, as compared with the same period of last year. In spite, however, of a financial depression (more properly a financial stringency or tightness in the money market) in the United States, the report of the Bureau of Navigation, Department of Commerce and Labor, shows that during the nine months ended March 31, 1908, the tonnage of sail and steam vessels constructed in the United States has increased by approximately 25 percent, as compared with the figures for last year.

The report shows 775 vessels aggregating 353,763 tons, or an average of 457 tons per ship, as compared with 679 vessels and 280,291 gross tons last year, the average here being only 413 tons. Construction has increased both on the Atlantic and Pacific coasts and the Great Lakes. The figures for these three divisions may be summarized as follows:

	1907		1908	
	Number.	Tons.	Number.	Tons.
Atlantic	365	92,582	355	102,372
Pacific	119	16,400	170	32,961
Great Lakes...	72	167,105	111	214,885

The great number of vessels shown is accounted for largely by the fact that 667 this year and 593 last year were built of wood, and were of small size. If, however, we confine attention to steel steamers, the item of real importance in the returns, we find that the gain has been from 81 vessels, 232,264 tons, and an average of 2,866 tons last year to 107 vessels, 295,682 tons, and an average of 2,762 tons this year. Here again each main division has shown an increase, the greatest being that on the Lakes, where the figures are, respectively, 165,793 tons and 212,477 tons.

In addition to the construction of sail and steam vessels there were many unrigged vessels (canal boats, barges, scows, etc.) included in the report, the figures being for nine months last year, 258, of 64,217 tons, as compared with 246 and 65,511 tons this year.

The Development of the Modern Freighter.

We are describing this month, side by side, a half-dozen steel steamers intended primarily for the carrying of freight, built by various yards in Britain and on the continent, and constructed from a variety of designs, some features of which were unheard of a dozen years ago. In the modern development of this type of vessel the tendency has been all along to dispense with obstructions in the hold, leaving a large, clear space free for the stowage of either bulk cargo or of large sections of machinery and other freight, with large hatches for loading and discharging cargo, and with powerful machinery for use in this connection.

Among the most prominent features of ships built according to this new principle might be mentioned a general tendency to place the propelling machinery right aft, with a minimum length of shafting and a minimum disturbance of cargo space by shaft tunnel, machinery casings, etc. This tendency has been carried to its logical limit in the big steamers which have been constructed in large numbers on the Great Lakes of North America. Not only has there been left a clear hold, reaching in some cases to more than 400 feet in length without a single break, but the arrangement of hatchways has been so standardized, in connection with the loading and unloading devices of immense power located at the various ore and coal docks on the lakes, that a minimum of time is required for either operation. These hatches are spaced either 12 or 24 feet between centers, depending upon circumstances; their greatest length is athwartship, reaching in some cases two-thirds the breadth of the vessel; and as the unloading machines are also 12 feet apart, this makes it possible to bring the vessel to such a position alongside the wharf that a score or more of these machines may be operated at once and an immense cargo discharged in a time which, to those not accustomed to this method of doing it, must seem incredible. The largest vessels of this service can carry more than 12,000 tons of bulk cargo in the shape of iron ore or coal. This immense quantity can be loaded into the vessel in from one and one-half to two hours, and such is the celerity with which it can be discharged by the special appliances in use for this purpose, that not more than five or six hours are consumed in this operation.

Among the vessels described this month we find that considerable reliance for loading and discharging is placed upon devices carried by the vessel herself, consisting in the main of large cargo booms operated by powerful winches. In the very nature of things this cannot accomplish the result in anything like the small amount of time required by the vessels on the Great Lakes. On the other hand, with the great diversity of character of cargo carried by the ocean-going vessels, and the totally unsystematized arrangements at the various ports to which they carry this cargo, no such unloading devices as obtain on the large fresh-water freighters above mentioned would be possible.

In general structural arrangement the designs are somewhat similar. In each case there is a deep double bottom, upon which reliance is placed in large measure for strength and stiffness of hull. Associated with this we find heavy frames in the shape of webs, stiffened by longitudinal girders and by efficient and, from some points of view, enormous brackets or gussets. These latter connect the frames to the double bottom and to such deck beams as are used. The latter are of great individual strength, and occur only between hatches. As a general rule, heavy longitudinals run alongside the hatches, with short beams from these to the frames. In some of the cases under consideration this month we find that the triangular spaces outlined by the gussets are used as top side tanks for water ballast, the idea being to avoid the great stability arm occasioned by the usual arrangement of ballast tanks, thus making the ship much easier in a seaway and tending to decrease the stresses to which she is subjected when operating under this condition.

In the interests of clearness of cargo space, pillars or stanchions are almost entirely dispensed with, and where they are used they are commonly made of great individual strength and set at long distances apart. In these cases they frequently carry heavy longitudinal girders for supporting decks and adding to the general strength of the structure. Along the same general line we might mention the fact that lower deck beams are practically eliminated, there being nothing across the hold from the top of the double bottom to the under side of the main deck.

All of these innovations, so to speak, have come gradually, and as the result of years of experience, experiments and developments, and it may safely be assumed that most of them have come to stay. The result is a ship in which a maximum of cargo-carrying capacity is associated with a maximum facility for handling this cargo, and with a minimum "tare" represented by weight of hull. The whole development is along sane lines, and, while we may expect to see it largely amplified and modified as the years go by, both as to the character of the individual construction and as to the number of units to which this construction is applied, yet we believe that the general features have already been developed, and that the ultimate type, if such a type is coming, will embody most of the present characteristics.

The Art of Making Sails

One of our articles this month, from the pen of the maker of the sails of most of the recent successful defenders of the *America's* cup, is especially interesting in that it takes up the whole subject matter of the elements conducing to success in a suit of sails. He points out the fact, not generally recognized, that the proper placing of the sails on the vessel is every whit as important as their correct cutting and manufacture. Directions are given for taking care of this point in such manner as to enable the reader to readily make use of the accumulated experience of years in the handling of sails. The subjects of shrinkage and stretching are carefully considered, and the methods shown of making allowance for either in a new sail, the idea being to so adjust the sail that, after "weathering," it may be a perfect fit, with the correct amount of draft.

This article is to be continued through three numbers, and then to be republished in pamphlet form, for more ready convenience of users.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

	Tons.	Knots		Feb. 1.	Mar. 1.
BATTLESHIPS.					
Idaho	13,000	17	Wm. Cramp & Sons	95 9	97 25
New Hampshire	16,000	18	New York Shipbuilding Co.	97 8	99 3
South Carolina	16,000	18½	Wm. Cramp & Sons	36 4	39 05
Michigan	16,000	18½	New York Shipbuilding Co.	41 6	45
Delaware	20,000	21	Newport News S. B. & D. D. Co	9 2	12 77
North Dakota	20,000	21	Fore River Shipbuilding Co.	17 5	21.4
ARMORED CRUISERS.					
North Carolina	14,500	22	Newport News Co.	97.	98
Montana	14,500	22	Newport News Co.	93 4	94 96
SCOUT CRUISERS.					
Chester	3,750	24	Bath Iron Works	96 2	98 38
Birmingham	3,750	24	Fore River Shipbuilding Co	96 2	96 69
Salem	3,750	24	Fore River Shipbuilding Co.	93 9	94 31
TORPEDO BOAT DESTROYERS.					
Number 17	700	28	Wm. Cramp & Sons	4 5	6 88
Number 18	700	28	Wm. Cramp & Sons	3 8	6 8
Number 19	700	28	New York Shipbuilding Co.	5 1	8 4
Number 20	700	28	Bath Iron Works	2 5	5 38
Number 21	700	28	Bath Iron Works	2 5	4 91
SUBMARINE TORPEDO BOATS.					
Cuttlefish	—	—	Fore River Shipbuilding Co.	99.	99.
Number 13	—	—	Fore River Shipbuilding Co.		23
Number 14	—	—	Fore River Shipbuilding Co.		23.
Number 15	—	—	Fore River Shipbuilding Co.		23
Number 16	—	—	Fore River Shipbuilding Co		16 3
Number 17	—	—	Fore River Shipbuilding Co.		7 5
Number 18	—	—	Fore River Shipbuilding Co.		7 5
Number 19	—	—	Fore River Shipbuilding Co.		7 5

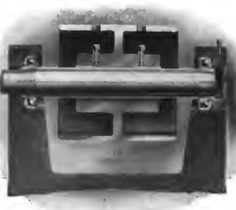
ENGINEERING SPECIALTIES.

Massachusetts Ball-Bearing Exhausters.

The ball-bearing exhausters now being manufactured by the Massachusetts Fan Company, Watertown, Mass., mark a distinct advance in fan-blower design. The bearings of the Chapman double ball type, with single ball races, are made of case-hardened cups forced into the hanger, and case-hardened cones forced on to tapered portions of the fan shaft. Between the two run hardened steel balls, separated by small ball idlers carried in light steel floats. The function of these floats is to keep the idlers in the center line of the larger balls, while the idler balls themselves eliminate the destructive grinding action of the load balls. The shaft may be readily driven out through the fan wheel, pulley and bearings; the taper contact between shaft and inner sleeve thus being easily broken. Such bearings have been run for months under various conditions without

showing the slightest signs of wear or deterioration.

This type of fan possesses many important advantages over the older forms. In the smaller sizes the bearing supports form an inherent part of the hanger, making a very compact and rigid combination, while insuring absolute alinement of the fan shaft. Freedom from the necessity and expense of oiling is also secured. Such fans may be placed in the most conspicuous place without collecting dirt and dust due to escaping oil. Journal friction has been almost entirely eliminated. As a great and added advantage, these fans in the smaller



sizes (up to 60-inch shell diameter) are made universally convertible, that is, they may be adjusted to discharge in any direction. The purchase of an entirely new fan, or even the change of hanger, is thus obviated.

Comparative tests definitely prove the superiority of the ball-bearing fan over one fitted with plain babbitted bearings. A summary of such tests shows a decrease of about 10 percent in the requirement below that necessary with the older type. To provide against misleading results in these tests, both fans were previously run for several weeks, so that they presented ordinary conditions. Such economy in favor of the ball-bearing fan shows an approximate annual saving of 25 percent of the purchase price of the fan.

The Sturrock Furnace Bridge.

A device intended to promote complete combustion of fuel is shown in our illustration. It is designed for both marine and land purposes, and has been fitted to a very large number of steamers. The special advantages claimed for this bridge are: Increased facility in removing and replacing bridges

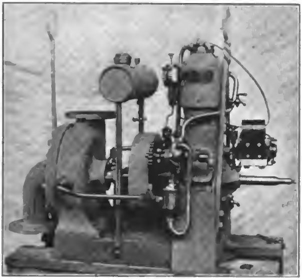
during inspection; facility in cleaning fires, due to such a construction of the bridge that clinker will not adhere to it; great durability, and a better combustion of fuel, resulting in greater economy, and a considerable reduction in the emission of black smoke.

The bridge wall is composed of cast iron bars with considerable air openings between. The dead plate, having openings through it, admits air freely from the ash pit to the back of the bars and through the spaces between to the fire, thus doing away with the usual pile of dead fire against the bridge wall. Air openings are also provided through the bars at the crest of the bridge, by which highly heated air is admitted to mingle with the gases from the furnace as they pass into the combustion chamber, thus effecting their complete combustion and preventing smoke.

This device is placed on the market by the Sturrock Patent Bridge & Engineering Company, Dundee.

A Small Pumping Set.

The illustration shows a 4-horsepower single-cylinder petrol (gasoline) engine, driving a centrifugal pump with 3-inch discharge, and capable of throwing 150 gallons per minute to a height of 20 feet. This set is placed on the market by J. W. Brooke & Company, Ltd., Lowestoft, and is mounted all on one bedplate, which forms a tank used for priming the pump.

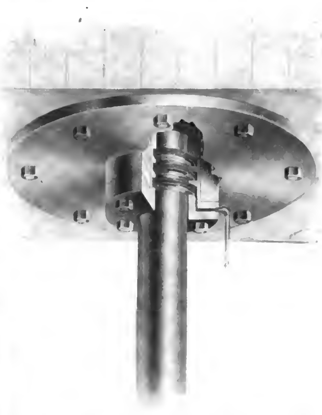


When the engine is running, the circulating water is drawn from one side of the centrifugal pump and returned to the other side, and in this condition the base is used as a silencer or muffler.

Ignition is by Simms-Bosch high-tension magneto, and the consumption of fuel at the full speed of 1,000 revolutions per minute is said to be only one gallon in 3 hours. Two slings are fitted for loading the outfit on a long pole, the entire weight being only about 500 pounds.

A Metallic Packing.

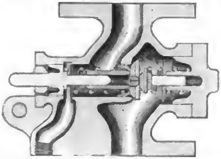
The Garlock Packing Company, Palmyra, N. Y., has developed a metallic packing of which our illustration shows a partial section. This is made extra strong for high-speed and high-pressure naval and other marine work, a special grade of bronze being used for the main wearing parts. Provision is made for collecting oil and water and discharging it through drain pipes, thus keeping the engine and its surroundings dry and clean. The packing, as shown, is fitted in three sections



with small glands, or "distance pieces," in between. The whole is then held in place, as usual, by a gland secured by studs. The packing is held tight against the rod by means of circular coil springs, which allow sufficient elasticity while still making a tight fit.

The Drainage of Steam Whistles.

Where the ordinary method of admitting steam into whistles and sirens of steam vessels is used, a great quantity of water, which has been condensed from the steam, remains in the pipes. Bends (where the water might collect) in the piping below deck are easily avoided; but the difficulty of preventing or getting rid of the condensation of steam in the piping above deck, where exposed to the cold air, has been a frequent cause of trouble. An ordinary stop valve is often fitted within easy



reach of the deck, but this is obviously dangerous, as there would be no time to open it should a sudden necessity to use the whistle arise.

A practical method of draining is employed on most of the vessels of the North German Lloyd Company, as well as on many ships in the German navy, the P. & O. Company, also a large number of other liners, passenger vessels and

private steam yachts, in the shape of a patent valve, which serves both as a stop valve and a whistle valve. This appliance, known as Moller's drain valve, is manufactured by the Combination Metallic Packing Company, Ltd., Gateshead-on-Tyne. It will be seen that by this arrangement no accumulation of water is possible; as when the steam is shut off from the whistle there is always a free passage for the condensed steam to flow away to any convenient receptacle.

The valve is fitted as close to the deck as possible, and is worked by a line led by a pulley to the bridge in the ordinary way. When the disk valve at right is closed, the piston valve at left is pressed back to allow a free drainage of the pipe through the port. On pulling the line, the piston valve first covers the drain, and then opens the disk valve. When the line is released, the disk valve is again closed by the steam pressure, and the piston valve is thrown back to reopen the drain. The instantaneous clear and full sounding of the whistle is thus rendered a matter of certainty.

TECHNICAL PUBLICATIONS.

Berechnung und Konstruktion der Schiffsmachinen und Kessel. By Dr. G. Bauer. Size, 5 by 8 inches. Pages, 820 + xxxvi. Figures, 623. Munich and Berlin, 1908: R. Oldenburg. Price, 24 marks (24/-).

This is the third edition of the work, and it has been thoroughly brought up to date by the addition of certain material on turbines and other items wherein large progress has been made since the publication of the first and second editions. The work is divided into eight main sections, of which the first includes the main engines; the second covers pumps; the third covers propellers and ship resistance; the fourth covers pipes used on shipboard for various purposes; the fifth covers boilers; the sixth treats of various devices for measuring; the seventh is a collection of items such as platforms, gratings, engine and boiler foundations, lubrication, disposition of ashes, etc.; while the eighth consists of forty tables of mathematical quantities, metric and English conversion units and various tables covering nautical practice.

The work is well illustrated, some half-tone engravings being printed on folding plates in order to give a large illustration, for the page would be too small for this purpose. Many line drawings are similarly placed, and the result is a thoroughly satisfactory volume from every point of view. With characteristic German thoroughness the matter is taken up from the mathematical point of view, beginning with the determination of cylinder dimensions, and carrying the reader through the various parts of the engine and its auxiliaries.

The second edition has been translated into English, and it is probable that the present one will be likewise treated.

Refrigeration. By J. W. Anderson, M. I. C. E. Size, 5½ by 8½ inches. Pages, 242. Figures, 87. London and New York, 1908: Longmans, Green & Company. Price, 7/6 net.

The subject is taken up from the point of view of heat and its abstraction or removal from the body to be cooled, and reference is made to a complete analogy to this manner of regarding heat in the case of water, which will readily flow from a high to a low level, but to be transferred from a low to a high level it must be lifted or pumped; work must be performed and energy expended. The amount so expended will necessarily depend on the quantity in question and the height through which it is raised. In the same way heat pumps (refrigerating apparatus) require the expenditure of energy, the amount depending upon the quantity and the difference between the first and last conditions.

The first six chapters are devoted to these elementary considerations of heat and its transfer; the properties of fluids and gases, liquids and vapors, and the laws of thermodynamics. In the seventh chapter refrigerants are discussed, the general types of machines and operations outlined, and tables given showing the various characteristics of different types of apparatus. The remaining five chapters are devoted to the substances used as refrigerants, to the making of ice, the construction and insulation of cold stores and miscellaneous uses and arrangements of refrigerating plants.

Of particular interest is the chapter on cold stores, showing the methods of insulating the walls, doors, floors and ceilings in such a manner that heat may be kept out to such an extent as may be required in any particular case. This section, as well as the others in the book, is illustrated by both half-tones and line cuts, showing details of construction. With regard to insulation, the cases of the *Lucania* and *St. Louis* are mentioned, in the former of which certain portions of the depth of insulation are taken up by sawdust backed up by boards, paper and hair felt; while with the *St. Louis* there is an air space between two sheaths of boards, the other materials being paper, ruberoid and granulated cork.

An unusually complete index, covering more than twenty pages, renders the work easy of access as a reference book, and adds to its value as an elementary text book.

Handbook for the Care and Operation of Naval Machinery. By Lieut. H. C. Dinger, United States Navy. Size, 4⅝ by 6¾ inches. Pages, 302. Figures, 134. New York, 1908: D. Van Nostrand Company. Price, $2 net (8/3).

The larger part of the contents of this work has already appeared serially in the *Journal of the American Society of Naval Engineers*. The present volume includes slight modifications and numerous additions to the material there published, and is placed before the public as a concise and simple description of the care and operation of naval machinery, on many points not largely discussed in standard treatises on the subject of marine engineering. The information has been obtained largely from first-hand experience, but free use is made of many authorities.

The work is divided into six parts and thirty-two chapters. The first part deals with the operation of naval machinery; the second with the care and overhauling of the main engines; the third with fittings and auxiliaries; the fourth with the care and preservation of subdivisions of the hull; the fifth with special auxiliary engines, such as steering gear, air compressors and blowers; while the sixth part deals with spare parts, tools and stores, and tests of machinery and piping.

The work is illustrated mainly by zinc engravings. A few half-tones are used for illustrating certain portions of the text, and there are a number of manufacturers' cuts, showing special devices of various types used on shipboard. The whole thing appears to be thoroughly practical, and doubtless will be found of much value to operating engineers, not only in the navy but also in the mercantile marine. It is, of course, specially designed for naval use, and based upon naval practice, but this does not render it less valuable in the merchant service.

Marine Boiler Management and Construction. By C. E. Stromeyer. Size, 6 by 9 inches. Pages, 404. Figures, 452. New York and London, 1907: Longmans, Green & Company. Price, $4 net (12s. net).

This is the third edition of a work which was issued first in 1893. It deals entirely with the return-tubular boiler, popularly known as the "Scotch" boiler, this type having stood the test of many years of operation. The main addition in this edition has been along the line of materials and better methods of working them, due to a better knowledge of their structures and elements. This includes a study of the microscopic structures of various steels, and also a study of gas analysis and its relation to the up-take and funnel.

The work is divided into eleven chapters, the last two of which summarize the boiler rules of Lloyd's Register and the

Board of Trade. The other chapters cover, respectively, boiler management, steam and water, corrosion, fuels and combustion, heat transmission, strength of materials, mechanics, boiler construction and design. The numerous illustrations are all in the nature of sketches, showing the various parts and the strains to which they are subjected and the methods of achieving definite results from given material. The subject of riveting comes up for extensive treatment under the heading of "Boiler Construction." A comprehensive index at the rear of the volume makes it easy of reference.

The Engineering Index Annual. Size, 6¼ by 9¼ inches. Pages, 435. New York and London, 1908: *Engineering Magazine*. Price, $2 (8s.).

This exceedingly valuable reference work is compiled from the Engineering Index, published monthly in the pages of the *Engineering Magazine*. The first four volumes of the series cover in each case a number of years, while this is the second annual volume. In each case the subjects are taken up under eight general classifications: Civil engineering; electrical engineering; industrial economy; marine and naval engineering; mechanical engineering; mining and metallurgy; railway engineering, and street and electric railways. Five of these eight headings are largely subdivided to make reference the more easy, and it may be stated in passing that the references are taken from some 250 technical periodicals published in half a dozen languages.

The section of particular interest to our readers is that devoted to marine and naval engineering, and covering seventeen pages of the work. Each article reviewed is given four or five lines, stating the general scope, indicating whether or not it is illustrated, the approximate number of words, and the date and place of publication. Not only is the article given reference of this sort, but the publishers hold themselves ready to furnish complete articles in every case, where not out of print.

The importance of such an index to an engineer can scarcely be overestimated. All articles of any importance appearing in the technical journals all over the world are placed on record in such a manner that they may be readily kept track of for any purpose at hand; and, of course, the record, being carried on from year to year, is in a measure self-perpetuated. Each new volume keeps the whole matter thoroughly up to date, indexing, of course, only such items as have appeared during the previous year.

Harbor Engineering. By Brysson Cunningham, B. E. Size, 6¼ by 9 inches. Pages, 283. Figures, 248. London, 1908: Charles Griffin & Company, Ltd. Philadelphia: J. B. Lippincott Company. Price, 16s. net and $5 net.

This is a work divided into ten chapters, of which the first is introductory and deals with the history of harbors and harbor works from the earliest times. The other chapters cover, respectively, harbor design; surveying, marine and submarine; piling; stone, natural and artificial; breakwater design; breakwater construction; pier heads, quays and landing stages; entrance channels, and channel demarcation.

The work is taken up in a very comprehensive manner, and is well illustrated by both sketches and half-tones taken from photographs and drawings. It covers, of course, the civil engineering features connected with the reclaiming of land; the dredging of harbor anchorages and channels; the deposit of material, both at sea after dredging and in position for the location of a pier or breakwater, and of all the various engineering features incident to preparing waterways and roadsteads for the safe use of shipping. A number of charts and plans of various harbors are given, showing examples of work actually accomplished or under way, while sketches are given also of many of the devices, such as cranes, hopper barges, etc., for carrying out work of this character.

The Steam Turbine. By Robert M. Neilson. Size, 6 by 9 inches. Pages, 604. Figures, 387; forty-six full-page plates; ten folding plates. London and New York, 1908: Longmans, Green & Company. Price, 15s. net and $4.20.

This is the fourth edition of a work which, appearing first in 1902, stands on record as the first extensive book on a subject now recognized as of very great importance. Much of the previous work has been completely rewritten and a great deal of additional matter, including seven entirely new chapters, has appeared since the third edition. As indicating the great increase in size of the work it might be mentioned that the first edition contained only 163 pages (each considerably smaller than the present) and 145 figures.

The aim throughout has been to render the subject intelligible to the average English-speaking operating engineer, whose training along scientific lines has not been extensive. The various formulæ employed have generally been arranged to be suitable for any system of units, but where clearness of effect could be gained by fixing the units, the usual British system has been adopted. The effort has been to combine in one connected treatment a discussion of the turbine historically, theoretically and practically, and in the latter connection the purpose has been to describe not only the principal parts of the leading types of steam turbines, but also the small details, which have such a large effect in determining the success or failure of the turbine as a whole.

The chapter of most immediate interest to our readers is the last one in the book, covering ship propulsion. This carries the reader through the main development, starting with the *Turbinia* of 1894, and culminating for the present in the *Lusitania* of 1907. This chapter, which is one of the most extensive of the entire work, covers the various arrangements for placing the turbines, and gives particulars of comparative trials between turbine and reciprocating ships. Both mercantile and naval vessels are described, as well as yachts, the whole being a complete résumé of the subject up to date. Attention has been confined almost exclusively to the Parsons type of turbine, although some of the others have been given brief mention. At the end of the volume is an appendix covering in categorical order the British patents relating to steam turbines up to the end of 1905. An index of sixteen pages completes the volume. The illustrations are uniformly good, though of the zinc rather than of the wax type, and are given in such profusion as to illustrate very nicely details and general construction of the turbine and its principal parts.

QUERIES AND ANSWERS.

Questions concerning marine engineering will be answered by the Editor in this column. Each communication must bear the name and address of the writer.

Q. 401.—Will you give a formula showing the relative strength of a deck beam with curvature (or arched) as compared with the same beam which is straight between points of support? C. E. C.

A.—If the ends of the beam are so fixed that there is no hindrance to horizontal movement, the beam is no stronger when curved than when straight. As a matter of fact, it is slightly weaker, on account of a small thrust along the tangent line to the beam at any point.

If, however, all horizontal movement of supports can be absolutely prevented, then the curved beam partakes of the nature of an arched rib with fixed ends. If not too flat, it is then stronger than if straight, on account of the arch-action.

The deck beam of a ship is supported with some rigidity at its ends, but the elasticity of the vessel as a whole would probably place it somewhere between the two cases above mentioned. In any event, no formula is available, each special case having to be treated separately. If the deck beam were

considered as having its ends so fixed that a slight yield of the supports might take place, the beam would become a simple curved beam, and would have no more strength than the straight beam, if as much. I. P. C.

The reason for giving crown or "camber" to the deck beams of a ship lies rather in the ability of this form to throw off water than in any idea of increasing the strength of the beam. Beams below the waterline are commonly not curved.

Q. 402.—What is the approximate horsepower absorbed by the auxiliary engines in a large liner; merchant ship; ironclad; cruiser; destroyer and torpedo boat? Also the weight? V. C.

A.—As a general proposition the shipbuilder does not give out figures of this sort, particularly with regard to the weight. It is often possible to obtain the power of the auxiliaries in warships, from published reports, but in merchant vessels this is rarely available. As a single instance, however, we know that the electric plant on the *Lusitania* and *Mauretania* is capable of developing 1,500 kilowatts, or 2,000 horsepower. The power of the balance of the auxiliary machinery is not generally made public.

From various trial trips of American battleships we have constructed a small table showing the power developed by the main and auxiliary engines, the total and the percentage which the auxiliary figure bears to the total. Some of these trials were under reduced power, while others were full power trials.

	Main.	Auxiliary.	Total.	Percentage.
Virginia	22,501	967	23,468	4.11
Louisiana	20,442	908	21,350	4.26
Nebraska	20,947	964	21,911	4.4
Minnesota	19,896	676	20,572	3.29
Minnesota	14,554	562	15,116	3.72
Ohio	12,670	280	12,950	2.16

It will be noticed that there is considerable variation in the percentages, which is easily explainable. In the first place, under forced draft the blowers are exerting a much larger proportion of the total power than under other conditions. When the ship is steaming at a low speed, many of the auxiliaries are running at almost the power required for full speed of the vessel, thus increasing largely their percentage. Various other features enter into the problem, and no definite figure can be given from which to work in design. Each particular unit of the auxiliary machinery must be considered separately.

Q. 403.—How do you estimate the shearing stresses in the rivets of the longitudinal seams of shell plating on a large steamship? A paper read before the Institution of Naval Architects in 1896 gives the formula: $q = \dfrac{F \times m}{I \times 2t}$

G. B.

A.—The usual method is to follow the rules of the classification societies, which are based on years of experience. They are wholly empirical, and are not usually susceptible to mathematical treatment. We know of no reliable formula which would permit the shearing stress to be determined with any accuracy.

Q. 404.—Please give formula for approximating the horsepower of single, triple and quadruple expansion steam engines at various steam pressures. B. P.

A.—The general formula for horsepower is:

$$H = \frac{2\,p\,L\,A\,N}{33{,}000}$$

This takes care of one cylinder only, and gives the result in horsepower when p is the mean effective pressure; L is the length of stroke in feet; A is the mean area of the piston, and N is the number of revolutions per minute. For an engine of more than one cylinder, the same formula is used for each cylinder, and the sum taken for all cylinders.

If it is desired to approximate to the horsepower of a triple-expansion engine, knowing only the steam pressure at the throttle and not the mean effective pressure, a fair approximation may be made by the use of the formula as given, where A refers to the high-pressure cylinder, and p is the pressure at the throttle. The figure thus obtained, multiplied by a factor (approximately 0.53) and by the number of cylinders (by three only, if a triple-expansion engine, whether there are three or four cylinders), should give a result somewhere near the proper one.

To check this we might take the official trial trip of the battleship *Virginia*, which has a high-pressure piston 35 inches in diameter, with a stroke of 4 feet. The piston area is 962 square inches, the revolutions on trials were 130, and the steam pressure at throttle was 228 pounds per square inch. Applying this formula and multiplying by 6, to take account of two triple-expansion engines (there were in reality eight cylinders) we obtain 21,950, where the actual figure was 22,501 horsepower. It will be seen that this is sufficiently close for many purposes. This method cannot, however, be recommended, except where the required data for the more exact method cannot be obtained.

Q. 406.—During the severe zero weather of the past winter, the steam pipe leading to the whistle was always kept under steam to prevent damage. In spite of this precaution, the top half of the pipe would freeze, while the lower half would not. The pipe, which is covered with asbestos cork and canvas, is perpendicular from the whistle to the deck, except for a slight bend near the whistle. Under the deck there is a good incline to the valve on the boiler. Was this freezing caused by the condensed water at the end of the pipe being held up by the steam pressure? Or would the water, being heavier than steam, flow back to the boiler as the steam condensed? There was no bend to trap it. J. B. S.

A.—The probability is that the steam in the pipe was gradually condensed, due to the very low temperature of the outside atmosphere, and particles of water clinging to the walls of the pipe were frozen before they could run down to the boiler. The whole question, especially as to the point above which freezing occurred, and below which it did not, may be traced to a very delicate adjustment between the effects on the condensed water, thus running down the walls, of the heat from the steam within the pipe on the one hand, and the low temperature from outside on the other. It is possible that a continued freezing action of this sort might conceivably have filled the pipe with frozen condensed steam for some little portion of its upper length, in spite of the fact that all surfaces so covered were at the same time subject in a certain measure to the high temperature of the steam within the pipe.

Carl A. Creutz, formerly of the Fore River Shipbuilding Company, has taken the position of managing director of the Ochta Shipbuilding & Engine Works, St. Petersburg, Russia.

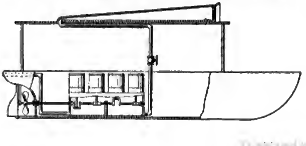
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

877,655. VENTILATOR FOR MOTOR BOATS. ABBOT A. LOW, HORSESHOE, N. Y.

Claim 2.—In a motor boat, the combination of an overhead awning or roof, consisting of a compartment formed with a forward air receiving



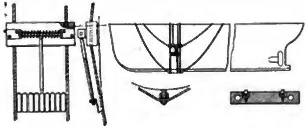
aperture, a flap arranged in conjunction with said aperture, a draining gutter under said flap, a conduit connecting the air compartment with the crank-shaft chamber of one or more hydrocarbon motors, and a discharge conduit connected with the crank-shaft chamber. Two claims.

876,470. MEANS FOR PROPELLING VESSELS. MARKUS F. MAUS, LYNBROOK, N. Y.

Claim 1.—As a means for propelling vessels, a piston mounted to reciprocate in a longitudinal channel of the vessel's hull, said piston comprising a blade pivoted to swing about an axis transverse to the path of the piston, and adapted to open as the piston moves in one direction, and to close as it moves in the opposite direction, a stop carried by the piston and mounted to turn about an axis transverse to the path of the piston and perpendicular to the first-named axis, to arrest the blade in the closed position either during the forward or during the rearward movement of the piston, and means for reversing the position of said stop. Fifteen claims.

877,745. VESSEL HULL SCRAPER. WILLIAM E. SCOTT, MONTREAL, CANADA.

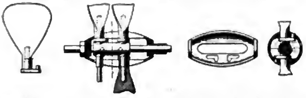
Claim 1.—In combination with a ship, a vertically and longitudinally adjustable block carried by the ship, bearings on the block, a rod rock-



ably disposed in the bearings, a spring coiled on the rod and having one end secured to one of the bearings and its opposite end secured to the rod, an arm secured to the rod, and scraping fingers supported by the arm. Four claims.

878,022. SPEED-CONTROLLING REVERSING PROPELLER. CHARLES F. ROPER, HOPEDALE, MASS., ASSIGNOR TO C. F. ROPER & CO., HOPEDALE.

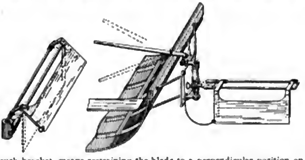
Claim 1.—A rotatable shaft, a hub fixed thereon and having rigid, radially extended and elongated bearing studs thereon in diametrically



opposite pairs, a propeller blade pivotally mounted on each stud, each blade having a deep socket extending well into the solid body thereof to receive the stud, and a single controlling means to effect equal and opposite angular movement of the blades of a pair, and also to vary the angularity of the blades of one pair relatively to those of the other pair. Eleven claims.

878,469. FEATHERING PADDLE ATTACHMENT FOR SMALL BOATS. WILLIAM RICKARDS, PORTLAND, OREGON.

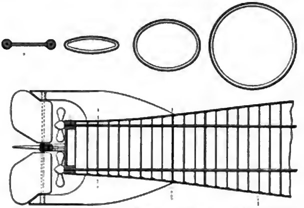
Claim 1.—The combination with a boat of a supporting frame affixed to the side thereof, a rod vertically pivoted in such frame, a bracket projecting horizontally from said rod, a dependent blade hinged to



such bracket, means restraining the blade to a perpendicular position on the forward stroke of the paddle, and allowing it to feather on the return stroke, a horizontal, pivoted handle bar and means connecting it with said pivoted rod, whereby the former is adapted to operate the paddle; the blade-supporting bracket being vertically movable on its supporting rod, so that the blade may be relatively adjusted to the depth of the boat in the water, and the parts being duplicated on both sides of the boat. Five claims.

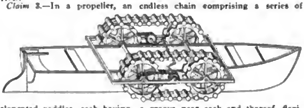
878,752. TWIN-SCREW SUBMARINE BOAT. L. Y. SPEAR, QUINCY, MASS., ASSIGNOR TO ELECTRIC BOAT COMPANY, NEW YORK, A CORPORATION OF NEW JERSEY.

Abstract.—The object of the invention is to provide a submarine or submergible boat, having the usual substantially circular cross sectional construction, with twin screws. To effect this object and to avoid outboard bracket bearings for the screw shafts, the stern section of the boat is gradually reduced or diminished vertically, from the substantially circular cross section of the major part of the hull, so as to finally merge, through gradually flattening elliptical cross sections, into a stern frame having substantially parallel sides, within which frame are formed the end bearings for the screw shafts. Three claims.



879,689. PROPELLER. ALBERT STANDAU, TERRE HAUTE, IND.

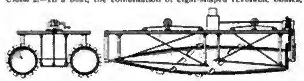
Claim 3.—In a propeller, an endless chain comprising a series of



elongated paddles, each having a groove near each end thereof, flexible means engaging said grooves for connecting said paddles together, flexible casings inclosing the greater portions of said paddles, and means for rotating said paddles. Six claims.

879,860. SPEED-BOAT. GEORGE A. FARRELL, CHICAGO.

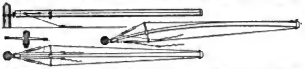
Claim 2.—In a boat, the combination of cigar-shaped revoluble bodies,



hydroplanes adapted to be secured between the bodies, a platform above the bodies and secured thereto, means for regulating the hydroplanes, and means for revolving the cigar-shaped bodies to propel the boat. Seven claims.

879,986. SAIL-BOOM. PERCY TATCHELL, LONDON.

Abstract.—According to the present invention, the sail is cut with little or no belly or flow, and is laced or otherwise fastened to the



boom, and the necessary belly or curve is imparted to the sail by bending the boom laterally to the required degree to give the best results under the conditions of wind prevailing. Six claims.

British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

19,247. SHIPS. PROPELLING BY SCREW PROPELLERS. A. M. MILLE AND C. A. F.-P. BIDET, HAVRE, FRANCE.

The tail shaft is mounted in a bearing adapted to turn about a vertical axis. The bearing is mounted in a spherical part provided with trunnions, the spherical part being secured between two portions of a stuffing-box having a gland. The stuffing-box is secured to the stern post and does not rotate. The thrust-block is mounted in a frame capable of rotation on trunnions. The vessel is steered by altering the angle of the propeller shaft to the center line of the ship. The packing of the gland is kept tight by springs, contained in hollow screws and acting on the sectors of a ring surrounding the packing.

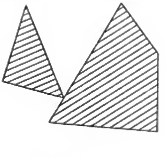
19,325. LIFE BOATS. C. LEHNERT, RUHRORT, GERMANY.

The hull is constructed in two portions hinged together at the stern, and united along the horizontal division by fly-screws passing through flanges. A lookout is provided at the bow of the boat. The vessel is propelled by paddle wheels actuated by any suitable means, and is steered by a rudder. Ventilation is effected through a pipe and a valve, which prevents ingress of water. The lower end of the pipe is screwed, so that a long pipe may be fitted in rough weather. The vessel is constructed of an aluminum alloy.

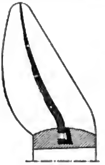
19,162. SAILS. G. J. TILLING AND T. T. CROWLE, SOUTHAMPTON.

Sails, of the type in which the seams are laid diagonally, for ships, yachts, etc., are constructed, in order that they may retain their shape, with the center of the width of the main cloth arranged, in the case of a mainsail or similarly shaped sail, in a direct line between the throat and clew, and, in the case of a sail of triangular shape, such as a jib or

topsail, at right angles to the stay, and extending in a direct line to the clew. The other cloths are fitted parallel to the seams of the main cloth.



19,162.



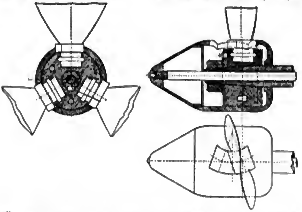
19,303.

19,303. SCREW PROPELLERS. L. GAYOTTI AND N. LAGANA, NAPLES, ITALY.

Propeller blades are built up of a number of sheets of metal, secured to each other by rivets of some soft malleable metal. The object of this construction is to provide a flexible blade. The thickness is reduced towards the tip by decreasing the number of sheets, and also the thickness of the individual sheets of metal. The blades are secured to the boss by keys.

19,911. SCREW PROPELLERS. J. ANDREWS AND D. CAMERON, KIRKINTILLOCH, STIRLINGSHIRE.

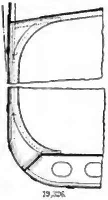
Relates to a reversible screw propeller for ships and boats, and of the type in which the blades may be turned axially by means of collars on the blade shanks working in curved openings in a sleeve surrounding the boss. Slots are formed in a sleeve provided with a cap, to which a rod, connected in a known manner with the reversing handle and passing through the shaft, is suitably secured. The slots are made preferably in the form of segments of a ring, and engage similarly shaped



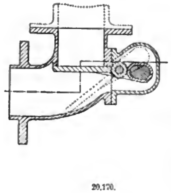
collars on the shanks of the blades. The boss is secured to the shaft by a key and nut or otherwise, is provided with flats on its periphery adjoining the outer collars, and is preferably laterally divided in halves. The movement of the sleeve relatively to the boss is effected in the case of small propellers by hand gear, and in the case of large propellers by a direct-acting or other engine.

19,326. SHIPS' FRAMING. E. H. CRAGGS, MIDDLESBROUGH.

The decks and double bottoms are constructed in the usual manner, and the frame girders are built up of two or more angles, the reversed or inner member being bent inwards at its upper part and secured to the deck beam. The lower part of the same member is bent inwards and secured to the tank top by lugs. The upper and lower portions of the frame girders are fitted with plates, constituting webs, and providing additional strength at these points. The girders may be of other sections, divided at the upper and lower ends. The invention is stated to be particularly applicable to single-deck vessels, in which it is desired to omit a tier of beams.



19,326.



20,170.

20,170. SEA COCKS. H. McLACHLAN, RUTHERGLEN.

A storm valve for use on board ship in connection with the discharge pipes of baths, lavatories, water closets, etc., is made preferably in the form of a disk valve, carrying a balance weight and hinged to lugs on the casing. The valve seat may be removable. An opening having a removable cover secured by bolts, etc., enables the pivot pin to be withdrawn and the disk valve to be removed for cleaning or repair.

20,473. SCREW PROPELLERS; DRIVING GEAR. G. J. A. BOURDONCLE AND A. E. LEYMARIE, PARIS, FRANCE.

The screw propeller is operated from a motor through bevel gearing inclosed in a casing attached to the stern. The horizontal shaft is driven from a flexible shaft attached to the motor, and is provided with a sliding clutch operated by a hand lever, so that the shaft drives either of the bevel wheels, or occupies a neutral position. The vertical shaft is inclosed in a casing and drives a horizontal shaft, upon which the propeller is mounted, by bevel gearing. By means of the clutch, the vessel may be driven ahead or astern, or the motor may run light. The blades of the propeller are screwed into the boss, and secured by keys and screws, so that they may be set at any desired angle.

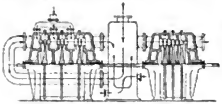
21,030. BOATS; LAUNCHES; PLANKING. S. E. SAUNDERS, COWES.

The inside framing of boats consists of a series of narrow strips of wood of convex or approximately triangular section. These strips may

be worked in any direction, and are close jointed. The outside planking is similar to the framing, but is worked in a different direction. A layer of canvas, saturated with a waterproof solution, is fitted between the framing and the planking. The interstices in the planking formed by the sectional shape of the planking are filled in with composition and covered with canvas. In a modification, the inside planking is of the sectional form, and the outside planking is constructed with hollow and round seams, intervening layers of planking being wrought in a direction opposite to that of either the framing or the planking. Layers of canvas are provided, and the whole structure is firmly secured together.

21,063. ELASTIC-FLUID TURBINES. F. W. SEYBOTH AND E. K. A. BAUMANN, ZWICKAU, SAXONY.

A turbine driven by air at atmospheric pressure which is heated by combustion products is arranged with a regenerator between the turbine and a fan which draws the exhaust from the turbine, so that fresh air passing to the turbine is heated to a certain extent by the exhaust. The combustion product is supplied to the turbine at each pressure stage. A turbine, divided into pressure stages, is supplied with fresh air by a pipe. The supply of combustion products at each pressure stage is effected by a main pipe and branch pipes. On the turbine shaft is arranged a fan, which draws the exhaust gases through a regenerator and discharges them through a pipe into the atmosphere. The exhaust gases may be cooled by the introduction of water by way of a pipe, or by the direct introduction of water into the fan. The turbine is started by compressed air from a reservoir.



21,063.

21,084.

21,084. OARS. E. NORRIS, RIVERSIDE, LONDON, S. W.

Oars, scolls, etc., are constructed in two or more longitudinal sections throughout their entire length, and with hollow looms. The inner portions of the looms are hollowed out, and are then cemented together, and further secured by screws, etc.

21,222. SHIPS. BULKHEAD DOORS. J. E. B. WAKEHAM, ARGYLL ROAD, ILFORD, ESSEX.

Consists of an arrangement of handles and gearing whereby bulkhead doors may be lowered from a central station, or separately from the deck, or from a position near the door. A square shaft carries two cams, one of which puts a half-nut into and out of gear with the raising shaft, while the other cam puts a corrugated brake into or out of gear with corresponding corrugations on the door. The shaft is operated by handles through a shaft and worm-wheel. Another shaft, operated from a central station, is geared with the first shaft by a clutch, which is put in and out of gear by a handle on the deck, or by a handle alongside the door.

21,296. SHIPS' HULLS, CLEANING. T. W. WILSON, DEVONPORT.

Apparatus of the type in which the brushes are rotated by screw propellers set in motion by the movement of a ship, or by streams or currents if the ship is stationary, comprises two propellers geared to a third propeller, the blades of which are arranged oppositely to those of the first propellers, and carry cleaning brushes or knife blades kept at a slight distance from the hull by means of short legs, provided with anti-friction rollers and fitted to the frame. Ropes are provided for moving the device over the surface of the hull, and the frame has eyes engaging guide-ropes.

21,352. SHIPS' CABIN LIGHTS. F. G. P. PRESTON, DEPTFORD, AND J. BURNS, BROCKLEY, KENT.

In a ship's scuttle or side-light, a tight joint is made between the ring containing the glass and the frame, by means of an india rubber or other elastic packing ring, which is surrounded by a metal band, wire rope, or chain adapted to be shortened to compress the packing ring. A lever, provided with a locking lever adapted to engage a fixed ratchet wheel, is mounted loosely on a pin in the frame, and may carry a latch fastening for the ring. The packing ring is contained in a groove in the frame. One end of the band is attached to the frame, and the other end is attached to the boss of the lever. At the point where the ends of the band cross, one part is slotted to receive the other part correspondingly reduced in width, or both parts may be halved.

International Marine Engineering

JUNE, 1908.

THE FRENCH ARMORED CRUISER EDGAR QUINET.

BY J. G. PELTIER.

The largest armored cruiser ever built on the continent of Europe was launched from Brest dockyard on Sept. 21, 1907. Her dimensions are as follows: Length over all, 515 feet 10 inches; extreme beam, 70 feet 7 inches; gross trial draft, 27 feet 4 inches; displacement at same draft, 14,158 tons; bunker coal carried on trials, 1,242 tons; designed speed for 10 hours, 23 knots.

The hull is of steel throughout, and is fitted with bilge keels, well shown in the photograph of her launching. Her protection consists of a complete belt of armor, 12 feet 2 inches wide amidships (7 feet 7 inches above waterline), and having a maximum of thickness of 6¾ inches amidships on about two-thirds of the ship's length. Gradually the thickness decreases from the middle of the hull to stem and stern, where it is only 4 inches forward and 3 inches aft. The thickness is also reduced from the waterline to the opposite edges of the two strakes of the belt side armor. Forward, there is a third strake running from stem to the forward casemates. Two armor athwartship bulkheads are worked from the shell plating at the ends of the casemates to the center barbettes of the 7.6-inch guns; they are made of 6¾-inch plating.

There are two protective decks, extending from stem to stern; the lower one is flat amidships and sloped at side and ends. The thickness is of 2 9/16 inches on the slopes and 1 19/24 inches on the flat. The upper one is flat and of 1⅜ inches. These two decks have their axis at the edges of the belt side armor. The side protection is completed with a cofferdam extending from the lower to the upper protective deck and a watertight bulkhead behind this cofferdam. Teak backing is fitted behind all the side armor. The conning tower has 8 inches thickness and the armor tube 5 inches..

Above the protective decks are the gun deck, worked from end to end, and the spar deck, running from stem to the after 7.6-inch turret. Above this deck are numerous bridges. As usual, the space between the belt side armor, the watertight bulkhead and cofferdam, and the two protective decks is divided by numerous compartments, filled with stores or water-excluding materials. Passages of any kind going through this space are protected with an annular cofferdam extending from foot to top.

The armament will be the most powerful of this type of cruiser in the French navy, but will be far less powerful than the usual armament of similar cruisers of the other leading naval powers. The battery will be mounted as follows: Four 7.64-inch guns in two electrically-operated elliptical turrets on the center line, one forward, one aft; they have an arc of fire of about 280 degrees; six 7.64-inch guns in six electrically operated, elliptical turrets on the spar deck, three on each side, like on the latest French battleships of the *Démocratie* type, and four 7.64-inch guns in four casements, two forward and two aft (fourteen such guns, in all).

THE LAUNCHING OF THE FRENCH ARMORED CRUISER EDGAR QUINET.

The turrets will have front and rear plates, 6.3 inches; splinter plates, 4.8 inches; top plates, 1.5 inches. The barbettes have front and rear plates, 6.3 inches; floor plates, 1.6 inches; inner tube, 1.2 to 3.2 inches; exterior tube, 19/24 inch. The casemates are formed with outside plating of 6.3 inches; inside plating, 4 inches; splinter plates, 5.5 inches; floor and top plates 19/24 inch.

The casemate guns are arranged to fire right ahead or astern, respectively. There will also be six 3-pounder guns on the gun deck; ten of the same on the spar deck, and eight on the bridges. Two 18-inch submerged torpedo tubes will be also fitted, forward. The main fire will consist of eight 7.64-inch guns forward or aft, and nine in broadside.

All ammunition rooms adjacent to heated compartments will be arranged with air spaces, and, since the disaster to the *Iena*, with refrigerating machinery. They are so arranged that about one-half of the ammunition will be carried at each end of the ship. The ammunition will be handled by hoists, trolleys and tracks, driven by electric motors.

The main engines consist of three sets of triple expansion, four-cylinder engines, having a total indicated horsepower of 36,000, and driving three propellers. Each engine will be located in a separate watertight compartment. The steam will be supplied to the main and auxiliary engines by Belleville watertube boilers, placed in two sets in several watertight compartments. The boilers will discharge the products of combustion into six funnels, 73 feet high above the base line, and 22 feet in diameter; three are forward and three aft.

The coal bunkers will have a maximum capacity of about 2,300 tons. With the ordinary bunker filling of 1,242 tons, the steaming radius will be at 10 knots, 6,000 nautical miles, and with the full bunkers, 10,000 miles. A certain quantity of liquid fuel may be shipped in the double bottom.

All compartments below the upper protective deck, except the coal bunkers, are fitted with forced draft. Special attention will be paid to spaces subject to habitually high temperature, such as engine, boiler and dynamo rooms. All blowers, except for the forced draft, are electrically operated. There are six dynamos.

There will be two lower bridges, forward and aft, chart houses and a flying bridge forward only. There are two steel masts, the forward one having a signal yard. There will be six searchlights, two in the masts, two forward and two aft. The two hawse pipes are so designed that stockless anchors will be stowed in them. The crew will be composed of thirty officers and 708 men.

	Edgar Quinet. France.	*Montana.* U. S. A.	*Shannon.* England.
Displacement	14,158	14,500	14,600
Horsepower	36,000	25,000	28,500
Speed, knots..........	23	22	22.6
Admiralty coefficient..	198	246.5	242
Main battery..........	14-7.64"	4-10"	4-9.2"
	......	16-6"	10-7.5"
Armor belt............	6.7"	5"	6"
Broadside, pounds.....	1,665	2,900	2,520
Coal, tons.............	2,300	2,000	2,000

SAIL MAKING.

BY ADRIAN WILSON.

Fig. 3 shows a fore-and-aft sail with the proper names of the different sides indicated, also the proper names of the different corners of the sail. Of the different arrangements of cloths which have been used in fore-and-aft sails, the two most used are shown in Figs. 3 and 4. Fig. 3 indicates the old arrangement of cloths, with seams running parallel to after leach; Fig. 4 indicates the present or crosscut arrangement of cloths, with seams arranged at right angle to after leach.

In headsails, Figs. 5 and 6 show old arrangement of cloths; Fig. 7 shows the new arrangement. We have also found cloths arranged in headsails in different forms as shown in Figs. 8, 9 and 10.

The tendency to stretch has always been greater in headsails than in the other sails. What our mothers and the seamstress would call a bias in a piece of cloth, sailmakers know as a gore or the diagonal side of the cloth. As the stretch in a cloth is so much greater in its length or warp, of course

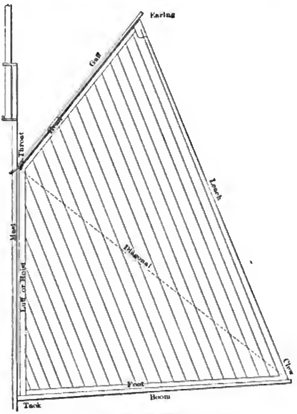


FIG. 3.—SHOWS OLD ARRANGEMENT OF CLOTHS.

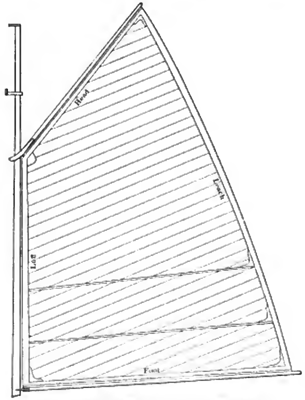


FIG. 4.—CLOTHS AT RIGHT ANGLE TO LEACH, AND CROSS CUT.

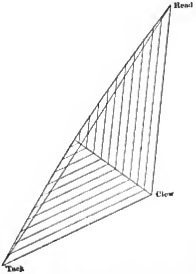


FIG. 5.—CLOTHS PARALLEL TO LEACH AND FOOT.

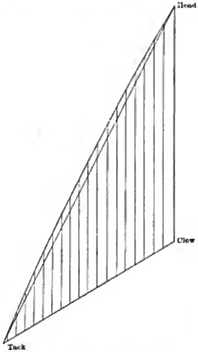


FIG. 6.—CLOTHS PARALLEL TO LEACH.

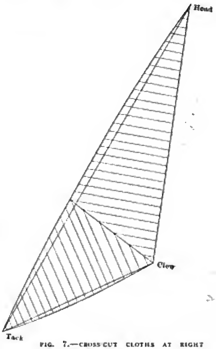


FIG. 7.—CROSS-CUT CLOTHS AT RIGHT ANGLES TO LEACH AND FOOT.

the nearer this gore comes to line of warp the greater the stretch. This unquestionably occurs to a greater degree in a headsail cut with cloths arranged parallel to the leach. With the filling or weft thread arranged so as to be parallel to leach of sail, this gore of the cloth is greatly shortened, and as a result we have only a small amount of stretch to contend with, as can be readily seen by Fig. 11. *A-B* will show the length of gore with cloth parallel with leach of sail; *C-D* will show the length of gore with cloth at right angle to leach; and the same applies to the diagonal of the sail.

While this idea of arranging the cloths may seem new, it is not so, for as far back as 1836 to 1840 it was customary to cut headsails with cloths arranged across the sail, instead of perpendicularly. Why it came into disuse we do not know, except for the fact that these sails are not so strong, and will not wear as long; and at that time, and later, the majority of sails were made for working craft and not for yachts. The famous sloop *Maria* had sails made with crosscut arrangement of cloths. A large part of our work to-day goes to the amateur yachtsman, and, as the crosscut arrangement of cloths means less stretch, the problem of working out the sail is that much simplified, to the great benefit of the yachtsman. I trust that I have given an idea of why we have so universally adopted the crosscut arrangement of seams.

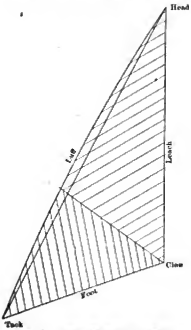


FIG. 8.—CLOTHS DIAGONAL IN LEACH; SQUARE IN FOOT.

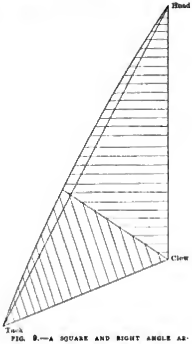


FIG. 9.—A SQUARE AND RIGHT ANGLE ARRANGEMENT OF CLOTHS.

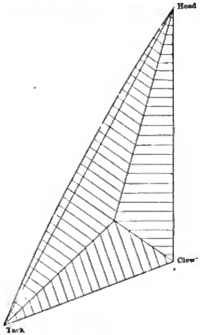


FIG. 10.

In the making of sails with cloths perpendicular to the leach, we established certain rules for working the draft into the body of the sail. Take, as an illustration, Fig. 3, showing a mainsail. We have the sail, with the names of the four sides and corners properly indicated. If it was our intention to make this sail a flat plane, it would appear, at the first glance, that all we had to do would be to cut out on the loft floor a sail whose four sides would be straight lines, sew it together and bind the edges with rope to insure the proper

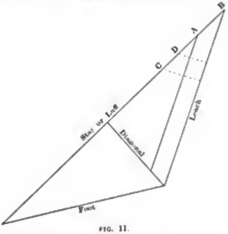


FIG. 11.

straight line—when the body of the sail filled with wind, the result would be that it would lift up the center of the boom into an arc above a straight line. The tendency of the head to do the same in an opposite direction would result in a light place through the center of the sail. So, we have the curves, or, as known to the sailmaker, the roaches, at the foot of the sail. There is a considerable roach, and it is our object to invert this curved line or part of it into the body of the sail, as shown by dotted line *A-B* in Fig. 12. This we do by tapering the seams in the sail, and it has been the work of years to get this operation to a point that would produce a perfect sail.

A sail made in this manner must be worked out on the yacht when in use by the most careful handling. These sails, which present a surface area of from 450 to 3,000 square feet—and some even larger—are made of a woven material extremely light, when compared with their areas, and are liable to be strained out of their proper shape very easily, by not being intelligently handled. The stress of the weather alone is very severe on them. In hot, dry winds the canvas goes out beyond its normal dimensions, and when wet shrinks inside of the same. So, with what care should a sail be watched? It should not be pulled too hard when dry, and should always be slacked in when wet. If the sail is a good one, under normal conditions it should never be strained out

A CLASS Q BOAT, WITH MAINSAIL AND BALLOON JIB.

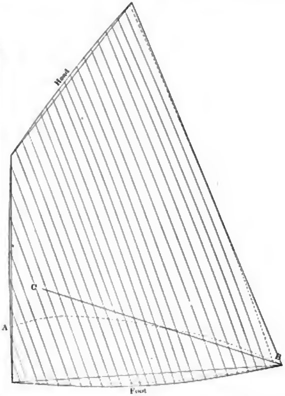


FIG. 12.

amount of strength. If made in this way it would not stand, as the wind pressing against this surface would produce results which no canvas, no matter of what fiber it was made, would have sufficient strength to stand; and it would tear at the points at which it is attached to the spars.

This is counteracted by certain curves put into the sail, which, when cut and sewed together and spread on the loft floor for the second time, would have the appearance of Fig. 12. The curved lines shown in Fig. 12 would show the sail as cut from the dimensions of Fig. 3, or as would be laid down by the sailmaker. If the sail should be cut with the four sides straight—for instance, if it were cut with the foot a

so that any undue strain can come on the line marked *B-C*, Fig. 12. This quickly takes all the draft from the body of the sail; and, if allowed to get thoroughly wet, with the clew pulled out too far on boom, the shrinkage on line *B-C* puts an undue tension on the canvas, and the sail becomes hard on this line, and its most important factor—the draft—is rapidly disappearing.

It also tends to hollow the line of the leach, which is always an indication that your sail is losing some of its best points. A new sail should show some considerable outer curve, and, when fully stretched to its dimensions on boom and gaff, should show a true, straight leach. One of the

greatest obstacles the sailmaker has to contend with is the tendency to pull a sail out on boom and gaff as soon as a little slack shows in head and foot rope. The sail may be perfectly dry, and the ropes the same. It will naturally, under these conditions, show some slack at head and foot. This is only on the edge of the sail. Its body is all right. Let it alone. It is doing good work. If pulled out, it gets an undue strain diagonally from end to boom and gaff. It may become damp from the late afternoon dew or from a little fog, when the fullness is immediately taken up.

This constant pulling out on boom and gaff is the cause of throwing the leach into bad shape, as in Fig. 13. The full line *C* is the line of the sail when new. Now, at *A-B* and *A'-B'* the sail does not stretch; in fact, it grows shorter at these points. If the sail is stretched out so that the leach has become a hollow line like *D*, there is a terrific girt strain in the sail, as indicated by the lines *E*, and the real leach is at about *F*, which will invariably cause a tight place in the sail, from boom to gaff, just forward of *F*. This not only causes trouble at the leach of the sail, but it has pulled all the draft out of the forward body of the sail, and it has become a flat surface from luff aft to a badly setting leach. The greater part of our effort as sailmakers is to construct our sails so as to overcome this very thing. Yachtsmen seem to be possessed with the idea that every bit of slack canvas must be stretched so that the sail is like a drumhead. While this may produce an entirely smooth surface, the very elements that constitute a fast sail may be destroyed. It may produce a picture sail, but not one that has the "go" in it. It would be a very easy matter for us if we had only to make picture sails, but our object is to turn out a sail that will have the "go" in it, and yet be a perfect sail in appearance. As the yacht is a thing of beauty, so the sail must be a part of it.

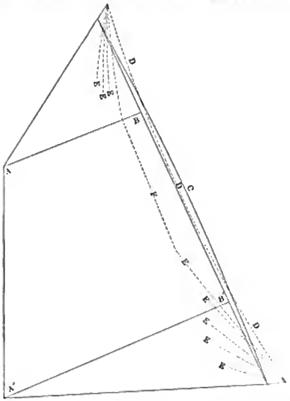


Fig. 13.

As before explained, canvas or any other woven material will stretch much more in the diagonal than in any other direction, so it should be an object to relieve the diagonal strain to which the sail is subject as much as possible. As pulling out on boom and gaff tends to increase the diagonal strain, our advice is to avoid it as much as possible.

As a very notable illustration of what can be accomplished in a racing sail, if the sailmaker's instructions are followed and sail not pulled out on boom and gaff as soon as a little slack shows, we cite the instance of the 22-footer *Tyro*, owned by William H. Joyce, and built to sail in the 22-foot class, Massachusetts Yacht Racing Association. The sails made for this boat were cut on the understanding that they should be finished to exact limit of sail plant; no allowances were made for stretch. The boat in all of the races was sailed by the late Sumner H. Foster. Particular care was taken by both Mr. Foster and Mr. Joyce that the sail should not be pulled out. It was raced for two entire seasons, and the only change made in the sail was finally in the second season to shorten on gaff about 3 inches, with the result that the original draft, which was put into the sail when new, remained. The sail did the wonderful feat of assisting the boat to win the championship in this class in the Massachusetts Yacht Racing Association for two seasons in succession.

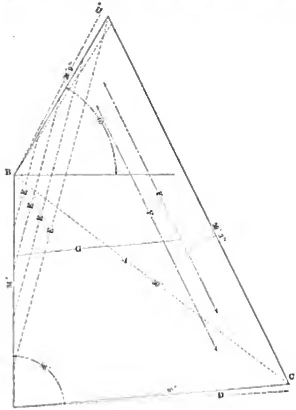


Fig. 14.

The same advice applies to setting the sail and keeping it properly set while in use. If the sail is not properly set at first, it cannot show to its best advantage. One grievous fault is that of not setting the peak up to its proper angle. In these days of steel halyards there is no excuse for not having a sail set right at the start. In our experience, we have had many complaints of a sail having a bad leach, or the complaint would be that the leach was tight. On investigation, the fault would be found in the fact that the sail had never been set to the angle at which it had been cut. In many instances of this kind the complaint would often be that the boom was too low. In investigating the complaint, the sail would be set under personal inspection, and there would be no tight leach, and the boom would swing at its proper height.

INDEPENDENCE, BRACED SHARP ON THE WIND.

THE SIX-MASTED SCHOONER MERTIE B. CROWLEY, SHOWING ARRANGEMENT OF TWENTY-TWO FORE-AND-AFT SAILS. PHOTOGRAPHS, N. L. STEBBINS.

Let us glance at Fig. 14, illustrating a mainsail on which the peak angle is 60 degrees. Suppose, in hoisting this sail, that it has been hoisted until the luff measures 34 feet, and it is pulled out on head and foot to 26 feet 9 inches and 40 feet, respectively. If, in setting up the peak, it should be hoisted until the sail is perfectly smooth and shows no wrinkles—say to its cut angle of 60 degrees—the result would be that after a half-hour's sailing the give of the halyards and slip caused from the belaying of same on cleat or pin would cause the sail to settle down; also, the give of the canvas would have to be accounted for. The sail would assume the shape indicated by the dotted lines, and an undue strain would take place through the line *A* from *B* to *C*, causing the boom to drop down to dotted line *D*. The sail, if cut at 60 degrees peak angle, should have been set at 62 degrees, or enough to allow for the settling of the peak. A great many yachtsmen think that a mainsail should be hoisted until it is perfectly smooth. I trust you can now see that it should be set above that point in reality. When first hoisted it should show some considerable body of wrinkles under the jaws of the gaff, as indicated by lines *E*.

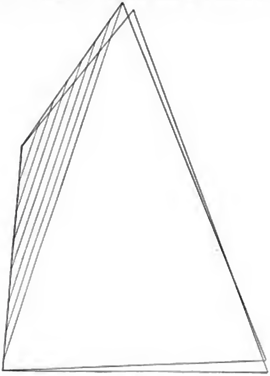


FIG. 15.

The fact that the end of the gaff has settled down below the designed angle, and at the same time the boom has also dropped to a point below plan, causes an undue strain on the canvas below line *B* to *C*. That is, the forward triangle of the sail has to take the whole weight of the sail, and instead of showing its true shape of a curve in forward body of sail, is thereby stretched until it is as flat as a board. Above *B-C* the sail is also in bad shape. It is more than likely that the sail is showing a hard place in the after body, extending about as indicated at lines *F-F*, and at the same time the leach has a tendency to be tight. In fact, the surface of the sail would look something like line *G*. This is somewhat exaggerated, but will convey the idea of the effect on the sail, or what happens when the peak is not properly set.

So, here are two distinct reasons for what may seem to be a tight leach: (1) Over-pulling sail on boom and gaff; and (2) not setting the peak to its proper angle. We have never known a case of a sail being spoiled by over-setting the peak, but have occasion very often to caution our customers to be sure the peak is well set up. When first set, the sail should show plenty of fullness in luff. The peak should be set until the sail wrinkles from gaff to luff (Fig. 15). This may look exaggerated, and may look to the yachtsman as if he were getting his peak up so much as to throw his sail all out of shape; but after the yacht is under way a short time it will be seen that the sail has come to its proper form, and is doing its best work. By setting the sail in this way it is sure to show a perfect leach, free enough to just tremble a little, but not so free as to slap or roll. Also, when sail is reefed, great care should be taken not to pull the reef ear-ring or reef cringle out too far on boom, for in doing this (that is, pulling reef too far out) it acts just the same as pulling foot too hard. These are some of the little details so necessary to know and so valuable, if followed, so that a good sail will always remain a good sail, and a poor sail be worked out into a fairly good one.

(*To be Concluded.*)

THE HEATING AND VENTILATING OF SHIPS.

BY SYDNEY F. WALKER, M. I. E. E.

THE THERMOTANK SYSTEM.

An apparatus that is now very much in use on board the leading great liners and others is that developed by the Thermotank Ventilating Company, of Glasgow, in which the ventilating and heating or cooling arrangements are united in one, as shown in Figs. 55 to 60. The apparatus is arranged either to force air down below under pressure or to exhaust it, the same apparatus being available for either, as may be required. It consists of a tank or cylinder, in which a certain number of tubes are arranged in a vertical position, the air to be warmed or cooled being drawn through them by means of a fan attached to and forming part of the plant. For heating purposes, steam is allowed to circulate around the tubes, a supply being brought for the purpose from the nearest steam service. For cooling the air, cold water or cold brine, according to the lowering of temperature required, is circulated. In addition a steam jet is arranged to provide moisture in very dry climates.

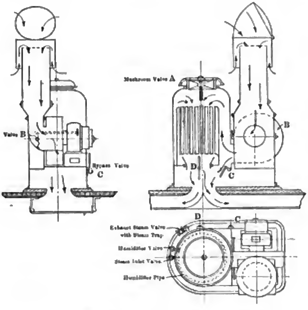


FIG. 55.—TOP-SUCTION DECK-TYPE THERMOTANK SUPPLYING AIR.

There are three forms of thermotank apparatus, which are known respectively as "top suction," "bottom suction" and "between decks." The top suction type, which is shown very clearly in Figs. 55 and 56, is taken from one fixed on the boat deck of the *Lusitania*, and has the cylindrical tank, common to all of the apparatus, in which the pipes are fixed. It has also the mushroom valve that will be seen above the cylindrical tank, and that is marked in the diagrams, and also a protected cowl connected to the fan chamber for the admission of fresh air.

When the apparatus is used to force air down into the staterooms, etc., the mushroom valve on top of the tank is closed, and the air passes from the hooded cowl through the fan up at the back of the pipes, down through the pipes, and thence into the ducts leading to the rooms to be warmed. When the apparatus is to be used for exhausting, the mushroom valve on top of the tank is opened, and the valves marked *D* and *C* at the base of the tank are closed. The air then, instead of being drawn from the hooded cowl, is drawn from below, and in place of passing through the tubes passes up by the side of them and through the mushroom valve at the top to the atmosphere.

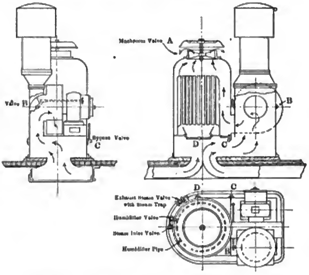


FIG. 56.—TOP-SUCTION DECK-TYPE THERMOTANK EXHAUSTING AIR.

The bottom suction apparatus is shown in Figs. 57 and 58. It is very similar to the top suction apparatus, the difference being the absence of the hooded cowl described above. In the bottom suction apparatus air is taken from below the fan, as seen in the diagram; is passed through the fan, and thence through the air tubes and down into the ducts leading to the rooms to be warmed or cooled. When the bottom suction apparatus is to be employed for exhausting, the mushroom valve above the tank is again opened, the valves *C* and *D* are again closed, and the valve *B*, which is shown in the diagram, in the suction duct leading to the fan, is also closed, the air from below then passing up through the fan, thence by the side of the air pipes and out through the mushroom valve at the top.

Figs. 59 and 60 show a between-deck apparatus. This is very similar to those described above, the difference being that it is fixed between decks, and takes its air from a duct or flue leading to any convenient supply of fresh air. It is used either for exhausting or forcing air down, just as the others are.

In all forms of the apparatus there is a steam pipe leading to the top of the tank, and an exhaust steam valve and steam trap at the bottom. A perforated steam pipe, surrounding the air tubes, provides the moisture when required. It has the

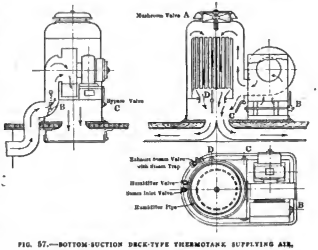


FIG. 57.—BOTTOM-SUCTION DECK-TYPE THERMOTANK SUPPLYING AIR.

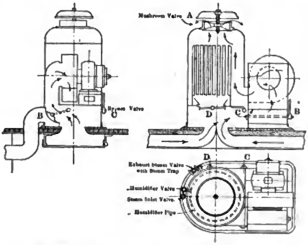


FIG. 58.—BOTTOM-SUCTION DECK-TYPE THERMOTANK EXHAUSTING AIR.

usual valves. For cooling, water or cooled brine, as explained, take the place of steam.

It will be seen, from the description, that the thermotank apparatus practically does for the compartments of a ship what the shafts and fans do for a coal mine. The thermotank apparatus appears also to have been more thoroughly worked out than the system of mine ventilation has, up to the present. It will be noticed that, providing that thermotank and ducts, etc., are provided for each compartment, the engineer has complete control of the ventilation, and the heating, warming and cooling of each individual part of the ship. It will be noticed also that any type of the thermotank apparatus can be used either to force air into the spaces to be warmed, or cooled and ventilated, or can be arranged to exhaust the air from them. This follows the practice adopted in ships which carry cold storage for fruit, in which the temperature is not required to be very low. As has been explained under "Cold Storage on Board Ship," in temperate latitudes the "freezer" engineer works the cold store upon the atmosphere. That is to say, he merely takes the air direct from the atmosphere, passes it through the store and forces it out again. In many latitudes it will evidently be more convenient, and more economical, to adopt this plan with the ventilating air current for shipboard use.

Another point that should be mentioned in connection with the thermotank apparatus, as will be seen from some of the

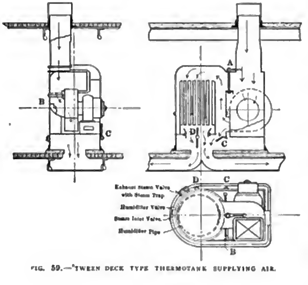


FIG. 59.—'TWEEN DECK TYPE THERMOTANK SUPPLYING AIR.

illustrations, is that it is arranged to regulate the speed of the motor, and with it the quantity of air passing into, or being sucked out of, the spaces operated upon. The regulating apparatus consists simply of an electrical rheostat, arranged to vary the current in the field coils of the electric motor, and thereby to vary its speed. It will be seen that this gives the engineer a more complete control than is possible with any other method, providing that the steps of the regulator can be arranged sufficiently close together. As mentioned, how-

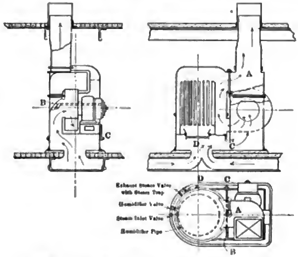


FIG. 60.—'TWEEN DECK TYPE THERMOTANK EXHAUSTING AIR.

ever, in a previous section, the ventilating air current increases very rapidly with the speed, because the volume of air is increased with the speed, and the pressure driving the air is also increased. It is necessary, therefore, that any regulating apparatus should be arranged very finely, so that the changes in the strength of the ventilating air current can be made very small indeed, and the changes in the atmosphere of the rooms under control made very gradually.

It is claimed by the Thermotank Company that its system is very much more efficient than any system of steam-pipe radiation, with exhaust ventilation, and as a proof of this claim are given the curves shown in Fig. 61, in which the time occupied in heating up the air of two Russian ships, one by steam and the other by thermotank, is given. In the figure, the time

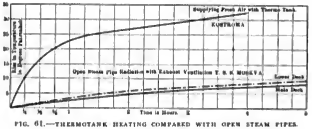


FIG. 61.—THERMOTANK HEATING COMPARED WITH OPEN STEAM PIPES.

in hours is plotted on the base line, as abscissæ, and the rise of temperature is measured by the vertical distances above the base line, as ordinates.

As will be seen, with the thermotank, heating commenced immediately. In a quarter of an hour the temperature had risen about 11 degrees F.; in half an hour it had risen 17 degrees F.; in one hour 22½ degrees F.; and it continued to rise up to 32½ degrees F. at the end of four hours. With the steam-pipe heating, the temperature rises only about 1 degree in a quarter of an hour; 2 degrees in half an hour; 5 degrees in one hour and two-thirds on the lower deck, and

a little over two hours on the main deck; the total rise in five hours being only 9 degrees on the lower deck, and about 8 degrees on the main deck.

These results are very striking, but though every credit should be given to the Thermotank Company for the way in which the apparatus has been worked out, the test in question by no means shows that an equal result might not have been obtained by the aid of steam, or by electricity, if the steam or electrical heating apparatus had been as suitably and carefully arranged as the thermotank apparatus was.

In these tests, the *Kostroma* was fitted with a thermotank supplying fresh air into a compartment of 14,803 cubic feet in extent. The heating surface was 208 square feet. There were 246 persons in the compartment, the air of which was changed 6.9 times per hour. There were 7 cubic feet of air supplied per person per minute.

FIG. 62.—TOP-SUCTION DECK-TYPE THERMOTANK FOR FIRST CLASS ACCOMMODATION ON LUSITANIA.

The *Moskva* had open steam pipe radiation, with exhaust ventilation. On the main deck, the compartment in question had a volume of 20,309 cubic feet, contained 262 persons, and was fitted with 202 square feet of heating surface. The air was changed seven times per hour, thus giving each person 9 cubic feet of fresh air per minute. On the lower deck, a compartment of 20,930 cubic feet was heated by a surface of 191 square feet. There were 284 persons, supplied each with 11 cubic feet of air per minute, the air being changed eight and three-quarter times per hour.

THE APPLICATION OF THE THERMOTANK TO THE STEAMSHIP LUSITANIA.

It will perhaps be interesting to describe the application of the thermotank system to one of the latest of the large ocean liners. The whole of the heating and ventilating of the *Lusitania* and *Mauretania* is practically carried out by thermotanks. These are arranged, a large number of them on the boat deck, and a small portion between decks. They deliver through ducts leading to all the spaces to be warmed and ventilated, and through louvre valves into each compartment, the valves being fixed near the ceiling. The warmed air passes in at the higher level, and is carried out by means of other valves near the deck, into the alleyways, etc., from which it is carried off to the atmosphere. In warm weather, when cooling

FIG. 63.—BOTTOM-SUCTION DECK-TYPE THERMOTANK FOR FIRST CLASS ACCOMMODATION ON LUSITANIA.

is required, the direction of the air current is reversed by altering the arrangement of the valves in the thermotank apparatus, as explained, and the air is exhausted from the different compartments through the louvre valves, into the ducts, and thence through the thermotanks to the atmosphere.

That portion of the ship allotted to first class passengers has twenty-four thermotanks, principally fixed on the boat deck, around the funnels, and they draw air principally from gratings opening on to the promenade deck shelter, so as to avoid drawing in air that is exhausting from the galleys, etc., on to the boat deck. When the thermotanks are exhausting, the air, of course, passes away, and the question of the odors from galleys, etc., does not arise. It appears to the writer that a certain amount of the injector action that has been mentioned will take place in the thermotank apparatus, when it is being used to exhaust, though the action will be reduced by the special arrangement of the protecting cowl shown.

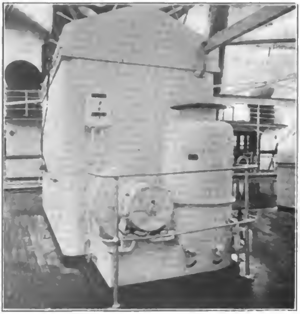


FIG. 64.—BOTTOM-SUCTION DECK-TYPE THERMOTANK FOR SECOND CLASS ACCOMMODATION ON LUSITANIA.

The space devoted to second class passengers has nine thermotanks; the third class, eleven thermotanks; and the officers and crew, five; the thermotanks being arranged on the tops of deck houses and where convenient. Those in the fore end of the ship are placed between decks, and fresh air is obtained for them from the upper deck abaft the navigating bridge, so that, it is claimed, a supply of fresh air is obtained in the worst weather without the exposure of cowl heads, etc., in the forward part of the ship.

The thermotanks are stated to be capable of changing the air in the different compartments up to eight times per hour, and of maintaining a temperature of 65 degrees F. in the coldest weather. The system of thermotanks is inner-connected, so that in case of the breakdown of any individual apparatus a supply can be obtained from one of the others.

The arrangement of inter-connection appears to the writer to be a very good one, though it necessarily somewhat complicates the apparatus. The large number of thermotanks that it

FIG. 66.—'TWEEN DECK TYPE THERMOTANK FOR THIRD-CLASS ACCOMMODATION ON LUSITANIA.

is necessary to employ (forty-nine in all) is also a matter for consideration, as it takes up a great deal of space on the boat deck and elsewhere ,and it adds to the apparatus to look after. On the other hand, the engineering staff of a large liner is thoroughly qualified to look after the apparatus, and, in fact. their labors, with ordinary care, should not be greatly increased by the employment of the apparatus.

In the *Lusitania*, in addition to the thermotanks, twelve powerful exhaust fans are connected by trunks to all the galleys, pantries, bathrooms, lavatories, etc., the fans being of sufficient capacity to change the air at least fifteen times an hour. The holds and other compartments, forward and aft, are also mechanically ventilated, so that the provision mentioned above of the air from the compartments finding its way to the alleyways, etc., and thence to the atmosphere, is easily arranged, and the whole system of ventilation and of heating and cooling the different compartments of the ship appears to be exceedingly well provided for.

One serious objection arises from the fact that it has been necessary frequently to supply both inside and outside staterooms from the same thermotank. The heat generated in the interior of these ships by the immense boiler plants, and dissipated and radiated, to a large degree, by both the main turbines and the numerous auxiliary engines, keeps the inside of the ship at a relatively high temperature; with the result that of two rooms, side by side, one being against the side of the ship and the other inside, there will be, particularly in winter weather, a difference of temperature amounting in some cases to as much as 10 degrees F., and occasionally much more. If, now, the same heat be supplied to each, the inner room will become insufferably hot before the outer gets comfortable. In such a case as this some auxiliary method of regulation becomes well-nigh imperative; and it is reported that this will be supplied by fitting small electric heaters to the outside rooms, and allowing these to make up any difference necessary between a comfortable temperature in the inside rooms and the corresponding temperature in those next the skin of the ship. Automatic regulation of these heaters should be provided, so as to minimize the consumption of current and conduce to the largest comfort of the passenger.

(*To be Continued.*)

A CLYDE-BUILT TURBINE YACHT FOR AMERICA.

BY BENJAMIN TAYLOR.

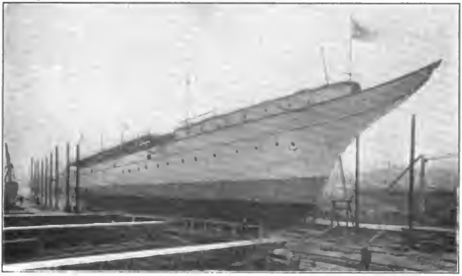
The steam yacht *Vanadis* has been built for C. K. G. Billings, of the New York Yacht Club, from the designs of Tams, Lemoine & Crane, of New York, by A. & J. Inglis, Glasgow. She will be one of the most prominent additions to the yachting fleet of America in 1908, and she is the first yacht of large size to be constructed abroad from American designs for American owners. She was launched Jan. 23, 1908.

Her dimensions are: Length over all, 277 feet 6 inches; length on waterline, 232 feet 7 inches; beam, 32 feet 7 inches, and depth, 19 feet 1 inch. With a draft of 14 feet the displacement is about 1,350 tons. The Thames yacht measurement is 1,230 tons, and the gross register tonnage about 1,075. She is about the same size as Mr. Vanderbilt's steam yacht *Warrior*, designed by G. L. Watson & Company, of Glasgow; but, with practically the same boiler power, the *Vanadis* has turbines, while the *Warrior* has reciprocating engines.

The *Vanadis* is built of steel throughout. She has eight watertight bulkheads and a double bottom, and will be practicably unsinkable in case of collision. She is classed 100 A1 at Lloyd's under special survey. Her bunkers hold sufficient coal to enable her to cross the Atlantic from Southampton to New York at a reasonable speed; at normal (trial) displacement she carries 135 tons. Her cold storage rooms will hold sufficient fresh provisions to feed all hands during three months. She is designed for general cruising, the designed speed being 15½ knots.

The vessel is high-sided, and has a long steel deck house amidships on the main deck, with shade deck extending the whole length of the house, and a topgallant forecastle. She is schooner rigged, with two pole masts and a large smokestack. To minimize rolling, narrow bilge keels are fitted over a portion of the length.

The owner's and guests' quarters are both forward and aft of the machinery space; the servants' and stewards' quarters are in the extreme afterpart of the vessel, and the officers and crew are forward. There is a servants' portion, with its own messroom, for the servants of the owner and guests. The owner's private rooms are at the after end of the main deckhouse. They consist of a suite of two large bedrooms (12 by



VIEW FROM THE STARBOARD BOW, SHOWING THE GREAT OVERHANG OF THE CLIPPER STEM.

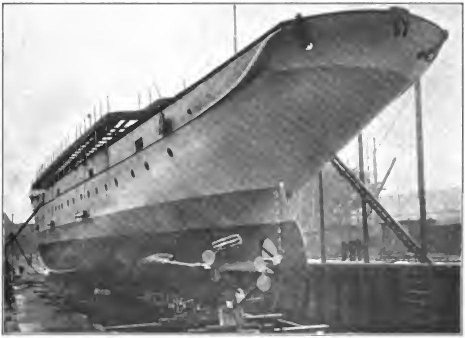
14½ feet, and 13 by 13½ feet) and two large bathrooms, with commodious wardrobe closets. The guests' quarters consist of eight staterooms and six bathrooms, arranged in suites.

In the deckhouse, forward of the owner's quarters, is a large vestibule, finished in English oak, and forward of this is a drawing room in white enamel (14 by 18½ feet), with an open fireplace at one end. From the drawing room a passage leads forward to a large dining room in oak, 22 feet long by 18 feet wide. In the deckhouse, between the dining room and drawing room, are the crew's galley, captain's stateroom, owner's galley and a large pantry. From this passageway a stairway leads to a large smoking room (11¼ by 16 feet) on the shade deck, and a chart room just aft of the smoking room.

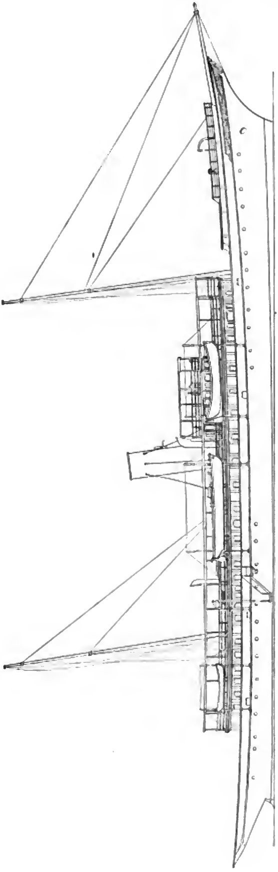
Ventilation has been carefully considered. In addition to a skylight for each room and port lights there is a forced system of ventilation which delivers air through ducts by means of a blower of sufficient capacity to change all the air in the vessel every ten minutes. She is heated throughout by steam.

The *Vanadis* has a shade deck amidships, and a raised forecastle, in which are quartered some of the officers, and where also are commodious store rooms. An electric elevator runs from the pantry to the store rooms. Provision has been made for carrying a large motor car on the forward deck, with arrangements for lifting the machine from the shore on to the boat.

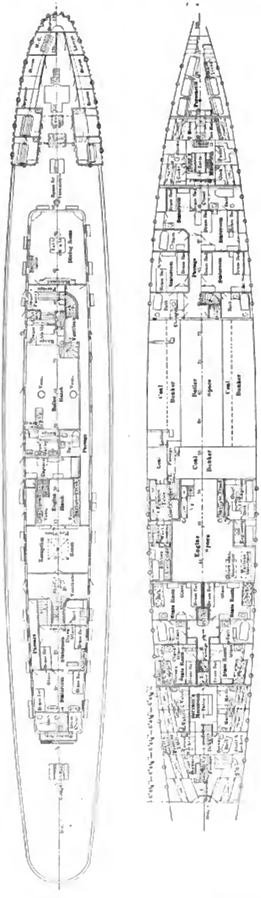
The propelling machinery consists of three Parsons turbines of a combined capacity of 3,000 horsepower, driving three bronze propellers. Steam is supplied from two single-ended Scotch boilers, 16 feet in diameter and 11 feet 9 inches long. Each boiler has four Morison suspension furnaces. The steam pressure is 155 pounds per square inch. Forced draft is provided for by two 25-inch Sirocco fans, direct connected to



STERN VIEW OF THE NEW TURBINE-PROPELLED STEAM YACHT VANADIS, BEFORE LAUNCHING.



THE OUTBOARD PROFILE SHOWS EASY LINES AND GRACEFUL APPEARANCE, WITH GOOD FREEBOARD AND AMPLE RESERVE BUOYANCY.



GENERAL ARRANGEMENT OF MAIN AND BERTH DECKS, SHOWING COMMODIOUS ACCOMMODATION FOR OWNER AND GUESTS—STEAM YACHT VANADIS.

electric motors, each operating at 825 revolutions per minute.

The design has been of attaining all possible economy at low speeds—the weak point of former turbine yachts having been the excessive coal consumption at the lower speeds. In carrying out this design the builders have had to use longer turbines than have been before built for such a low power. These turbines are arranged in the usual method—a high-pressure turbine on the center shaft and two low-pressure turbines on the wing shafts, each turbine driving its individual propeller. The wing shafts carry reversing turbines, which are capable of developing 60 percent of the full power. The engineers and firemen are quartered in the space directly adjoining the engine and boiler room.

There are two surface condensers. Included in the auxiliaries are two Edwards air pumps, two centrifugal circulating pumps, two vertical simplex feed pumps, and two General Electric generators. The latter are of 15 and 25 kilowatts capacity, respectively, one being (Curtis) turbine-driven.

The *Vanadis* carries six boats. Two 35-foot motor launches for the owner are driven each by a 75-horsepower Simplex engine. One of the launches is commodious and has a speed of 12 knots; the other is narrower, and has a speed of 22 miles. There is a crew's launch, 26 feet long, driven by a naphtha engine, and there are two 26-foot lifeboats and a 16-foot dinghy.

charter had expired the new yacht was under way. The *Honor* was taken as a basis, and to outward appearance the new vessel has a strong resemblance to her, but she is larger, and there are many points in which she shows a decided improvement.

The *Liberty* is schooner-rigged, with two pole masts and large smokestack, clipper bow with scroll head, and an elliptical stern. She is practically a three-deck vessel, though there is a short break at the foremast. This, however, is scarcely noticeable to a casual observer. On the top deck she has a long, unbroken range of steel deckhouses amidships, with chart room and flying double bridge above.

The accommodation has been carried out to her owner's ideas, and in this respect is something quite different from other pleasure vessels of her size. The part of the yacht forward of the machinery space is entirely devoted to the owner's private quarters and the store rooms; all the guests' rooms and the servants, officers and crew being aft. This insures entire privacy, in addition to which all the bulkheads have been specially "deafened" to eliminate noises from the engines, etc. To get forward, when necessary, the crew need not come on deck at all, for a special passageway has been arranged on the port side of the lower deck, leading from their quarters aft to the store rooms, etc., forward, and by a stairway they get to the forecastle deck.

THE NEW STEAM YACHT LIBERTY BEING FITTED OUT IN THE LEITH DOCKS, ALONGSIDE SEVERAL SAILING VESSELS.

THE TWIN SCREW STEAM YACHT LIBERTY.

BY BENJAMIN TAYLOR.

This fine steam yacht of 1,580 tons, Thames yacht measurement, has been built by Ramage & Ferguson, Ltd., Leith, for Joseph Pulitzer, of the *New York World*, from designs by J. R. Barnett, of G. L. Watson & Co., Glasgow. She was launched December 5 last, and is already in service in the Mediterranean. Mr. Pulitzer last year chartered Baron De Forest's 1,000-ton steam yacht *Honor*, which was also built at Leith from Messrs. Watson's designs, and so well was he pleased with that vessel that he commissioned the same designers and builders to do the work for him; and before his

In the range of deckhouses on the upper deck, commencing forward is the owner's library and study (15 by 17 feet), with lavatory and private vestibule adjoining; then there is the dining room, a very large apartment (16½ by 23 feet), in oak, from which an oak corridor runs aft on the starboard side to the drawing room (14 by 17 feet) aft of the machinery. On the port side there is a passage leading from the dining room to the main pantry, which is placed between the engine and boiler casings. The drawing room is finished in white, with panels of silk on the walls. A smoking room (12 by 14 feet) in darker oak is placed aft of the drawing room, and at the after end of this room there are double doors, which can be thrown open to a fine deck shelter, forming the after end of

the deckhouses. All these rooms have been specially designed by Murray, of London, and executed by Wylie & Lochhead, Ltd., Glasgow. By substituting for the ordinary lean-to skylights rectangular lights in the lower panels of the house (communicating by trunks to the rooms below), it has been possible to secure an unbroken promenade of over 8 feet in width between the house and the ship's side. These trunks are so arranged as to be covered by the furniture in the deckhouse.

On the main deck, the owner's rooms are forward. These are reached by a stairway from his private vestibule in the deckhouse. There is a large bed room (16 by 22 feet), and also a sitting room (12 by 21 feet), which may be used as a breakfast room, a bath room, etc. The windows of these rooms look out over the break deck, the side walls being kept in from the side of the vessel a few feet, though the deck above extends out to the side. This affords protection while giving ample light and air. The headroom everywhere is exceptional. Below these rooms on the lower deck there is another very large room, bath room, clothes room, etc., and forward of these is a gymnasium, fitted up with the best apparatus for getting exercise at sea. This gymnasium is a large room, and has great height (11 feet), extending right up from the lower deck to the break deck, with large skylight on top. There is a spray bath attached. A passageway on the lower deck, starboard side, allows the guests to enter the gymnasium. The part of the vessel forward of the gymnasium is occupied by the chain lockers, store rooms, a hospital with lavatory attached, lamp room and other offices.

On the main deck, on the starboard side of the engine and boiler casings, are five guests' rooms and a bath room. These are intended for bachelors. Aft of the casings there are six fine large staterooms, the smallest 10 by 11½ feet, and the largest 13 by 13½ feet, with two bath rooms and a boudoir. All these cabins are well lighted and ventilated. On the port side of the casings are servants' rooms, with a large sitting and mess room, cold larder, scullery, etc., and also the captain's room. The main galley is placed between the casings under the pantry.

The crew's quarters are all aft, occupying the whole of the lower deck aft of the machinery and that part of the main deck which is aft of the guests' quarters. There is a large open space on the main deck for the use of the crew, which may at will be closed by watertight shutters. Aft of this are the crew's galley, wash rooms, bath rooms, etc. On the lower deck, the extreme after end is occupied by the firemen. Forward of this the seamen are berthed on the port side, and the officers on the starboard side. In the holds are ample store rooms, those forward being reached by a trunk hatch from deck, as well as by an internal stairway for the steward. The cold rooms for owner and crew are very ample, a powerful refrigerating plant being installed.

The machinery consists of two triple expansion engines, with cylinders 16, 26 and 42 inches in diameter by 24 inches stroke. The propellers are of bronze, and are of different pitch, so as to reduce vibration to a minimum. There are two cylindrical return tube boilers of the Scotch type. These are of different sizes—the large one being ample to supply steam for cruising speeds—the small one suitable for use in port and for short runs at moderate speed. While there is no extravagance, all the latest improvements in auxiliary and deck machinery have been adopted.

There are two large independent electric light engines; a storage battery; a steam windlass on the forecastle deck, and a powerful steam capstan forward of this. The anchors are stockless, stowing in the hawse-pipes. Underneath, on the main deck, is an electric capstan for working a kedge anchor, and there are separate hawse-pipes for this purpose. Aft, on the main deck, is the steam steering engine, controlled from the flying bridge, and there is hand gear on the upper deck, immediately above the steering gear. On the upper deck right aft is a steam warping capstan. In the casings amidships is an electrically-driven boat-hoisting engine, with capstan heads on each side, so that all boats may be easily and rapidly handled. The vessel is heated throughout by hot water.

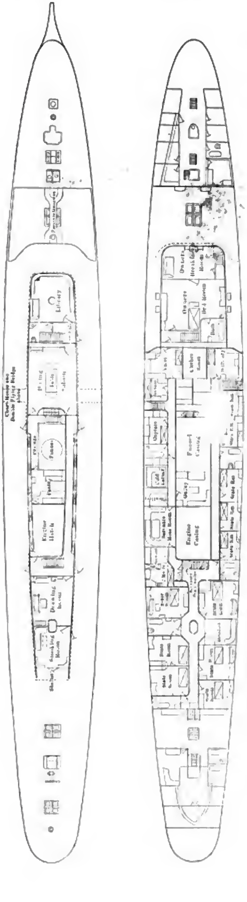
The *Liberty* carries four rowing boats and two steam launches, all berthed on skids above the upper deck, almost like a boat deck. From here the sails for steadying her in a seaway are worked, so that the upper deck is left quite free as a promenade. She is navigated from a flying bridge located above the chart room, which is situated on top of the deckhouse, just forward of the funnel.

The two steam launches were built by Simpson, Strickland & Company, Dartmouth. The larger of the two boats is 32 feet long by 6 feet 6 inches beam, and is built of specially selected mahogany with waterways and coamings. There is a small well forward, then comes the engine space, and immediately aft of this is a steering-well, so that the coxswain is not among the passengers, and yet within easy call. The seating arrangement in the after well is on a somewhat novel plan. The forward thwart is as usual, but the after thwart is specially wide, and carried right out to the sides of the boat, and is not joined by the fore-and-aft benches, so that there is ample and comfortable room for the knees of the passengers using it. At a distance of some 2 feet from this thwart are folding side benches on each side, giving plenty of room for all, while more passengers can sit facing forward than is possible with the ordinary arrangement. Folding hoods are fitted to both fore and after wells. The machinery consists of a triple-expansion engine, with cylinders 3, 4¾ and 7 inches in diameter, by 5½-inch stroke, working at a pressure of 175 pounds per square inch, and giving about 20 indicated horsepower. The speed of this boat on the official trial was found to be 8.67 knots—more than half a knot in excess of the contract.

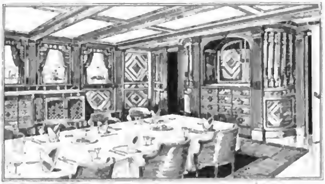
The smaller boat is 26 feet long by 5 feet 8 inches beam, and is of the same general design and construction, but the machinery is interesting, as being a good example of the successful use of oil fuel on the Lune Valley Engineering Company's system. The engine, a Kingdon tandem quadruple, having cylinders 2½, 3½, 4¾ and 6 inches diameter, with 3½-inch stroke, and working at 175 pounds pressure, gives about 10 horsepower. The boiler is a Lune Valley watertube type, using paraffin (kerosene) as fuel. This was found to give ample steam; in fact, throughout the official trials the regulator for the burner had to be slightly closed down, and this was found to give perfect control over the pressure. The speed obtained on trial was just over eight knots—more than a knot in excess of the contract.

On Jan. 31 the *Liberty* went out on her first steam trials in weather anything but pleasant. There was a stiff northwesterly wind blowing all day, approaching a gale in strength, and this afforded an excellent opportunity for testing her behavior at sea. She proved herself an excellent seaboat, easy and comfortable in motion, and the impression formed from an inspection of the vessel before she was launched was confirmed, in that she will also be a dry boat.

On the measured mile at Gullane, where there was a considerable sea, she had a few progressive runs, and a mean speed of 15¾ knots was easily obtained. The boilers gave ample steam, so there was no difficulty in maintaining this speed, which is considerably over the contract guarantee. A five-hours' continuous run was then undertaken at a cruising speed of 12 knots, during which run the auxiliary machinery was put through exhaustive tests, with successful results. During the whole day the machinery gave excellent satisfaction, without any hitch, notwithstanding the fact that this was the first run it had had. One remarkable feature of the day's



GENERAL ARRANGEMENT OF THE MAIN AND BERTH DECKS OF THE TWIN-SCREW YACHT LIBERTY, BUILT BY RAMAGE & FERGUSON, LIMITED.



THE DINING SALOON ON THE LIBERTY.
By courtesy *The Yachting and Boating Monthly.*

trials was an almost total absence of vibration, even at the highest speed.

The yacht has been specially designed for ocean cruising, and promises to be particularly well adapted for that purpose. She has very large bunkers, so that she can carry sufficient coal to allow her to cross the Atlantic and back again without coaling. For the same reason she has very large storage tanks for fresh water, besides having evaporating and distilling apparatus. In several features the designer has had to study utility as the chief object. She has a relatively flat bottom and moderately full ends, quite in contrast to the peg-top sections and hollow ends of earlier yachts. Her length on the waterline is 250 feet, with a beam of 35 feet 6 inches. She is about 300 feet long, over all.

The Twin-Screw Steam Yacht Iolanda.

The steam yacht *Iolanda*, of about 2,000 tons yacht measurement, was built for Commodore Morton F. Plant, of New York, by Ramage & Ferguson, Leith, from designs by Cox &

ONE OF THE UPTAKES FOR THE IOLANDA.

King, London, and under their superintendence. She is the second largest privately-owned yacht in the world. Her principal dimensions are: Length over all, about 305 feet; beam, 37 feet 6 inches; depth, 23 feet; length on the waterline, 258 feet; draft, 16 feet 6 inches. She was launched March 4, 1908. She is built of steel and is schooner rigged.

The twin-screw machinery is of the triple-expansion four-crank type, of about 3,500 collective indicated horsepower. One of the features is that her boilers are partly cylindical marine return tubular and partly watertube. This combination, the first installed in any yacht, affords the special advantage

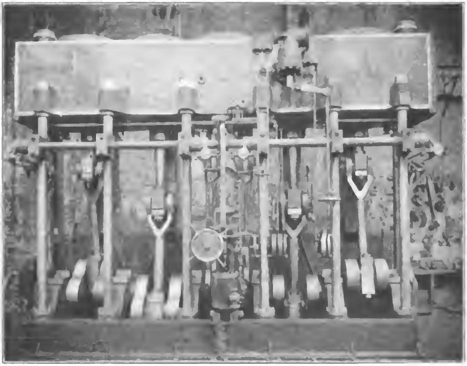
THE NEW STEAM YACHT IOLANDA, JUST AFTER BEING LAUNCHED BY RAMAGE & FERGUSON.

of enabling steam to be raised and the vessel got under way at practically a moment's notice. It also provides additional speed at short notice when required, while the bunker capacity of some 550 tons gives the yacht a very extensive ocean-steaming radius.

There are two inverted direct-acting surface condensing engines, each set having four cylinders, 19, 31, 35 and 35 inches in diameter and 27 inches stroke. The two cylindrical boilers are 17 feet in diameter by 11 feet long, with 321 square feet of grate area and 9,084 square feet heating surface, the ratio being 28.3 to 1. The two watertube boilers were built by the Babcock & Wilcox Company. The one funnel is elliptical in section, with a major axis of 15 feet, and is 55 feet high.

The outfit includes motor and steam launches, quick-firing guns, an elaborate system of electric lighting (the largest ever installed in a private yacht), and an installation of wireless telegraphy. The heating system throughout the yacht is by steam. The refrigerating plant, with cold chambers, etc., has been carefully planned, and has large storage capacity, including fish stores, dairy, etc. A spacious laundry is fitted up on the orlop deck, the laundry machinery being worked by electric motors. A comprehensive system of ventilation is installed, thirty motor-driven centrifugal fans being employed in this service. The electric plant includes three 30-kilowatt generators. The yacht is to be fitted with the Submarine Signal Company's apparatus, which is invaluable in fogs and greatly facilitates navigation. All underline closets are worked by George Jennings' special air-pressure system.

The accommodation for owner and guests comprises drawing and dining rooms, library, smoking room and other saloons,



THE FOUR-CYLINDER TRIPLE-EXPANSION PROPELLING ENGINE OF THE STEAM YACHT IOLANDA.

owner's state rooms and many guests' rooms, bath rooms, etc., handsomely fitted throughout. The general style of decoration is Queen Anne and early Georgian. The officers', servants' and crew's quarters are also very spacious, and arranged to accommodate about eighty persons.

The beautiful hardwoods are a special feature. The smoking room is paneled and framed with Genoa walnut, dull polished with egg-shell gloss. The framework and panels of the drawing room are in Honduras mahogany, flatted white, while the fitments are of West India satinwood, with panels of East India satinwood. The entrance hall and dining room, which are en suite, are treated in three different species of oak. The owner's private sitting room is paneled with beautiful pale green tapestry, and the framework, moldings, fitments and panels of fitments are in hardwood veneers. In the various other cabins are some beautiful examples of Italian walnut, light oak, curly oak, pollard oak, dark oak, linden, patapsco, East and West India satinwood, hardwood and sycamore.

The electric light fittings are from very chaste designs, specially prepared, and they are finished in dull gold, old brass and oxidized silver, respectively, and all the door furnishings, electric light switches, bell pushes, etc., are in metal, also to special designs, and finished to be en suite with the various electric light fittings. The windows of the principal saloons have sliding shutters, glazed with antique Venetian and muffled white glass, while the doors and over-doors of the state rooms are glazed with specially prepared designs in cloisonné glass.

NOTES ON STEERING GEAR.

The first successful steam steering gear was invented by McFarlane Gray in 1866, and the form of gear he patented is still fitted in almost all cargo steamers of moderate size. This gear is illustrated in Fig. 1. Steering chains are led to this engine from a quadrant or tiller fixed on the rudder-stock. The first cost of this form of steering gear is low, and as this factor bulks largely in ordinary cargo steamers, it is generally fitted in them.

In steamers over 400 feet long, steering gears working with chains are not so frequently fitted, as the upkeep of the chains is considerable, and the risk of a breakdown is multiplied by the number of links in the chain. Large cargo steamers, and almost all passenger steamers, are therefore fitted with some form of steering gear which acts directly on the quadrant or tiller. Three of these types are illustrated in Figs. 2, 3 and 4.

Fig. 2 shows a steam steering engine acting directly on a screw which is connected to the rudder-stock through a crosshead. This form of gear is very suitable for yachts, as it is practically silent in its action. It has the defect of being rigid, and as the rudder is apt to receive severe shocks in heavy weather, it has been found of great advantage to introduce some form of spring which will absorb these shocks.

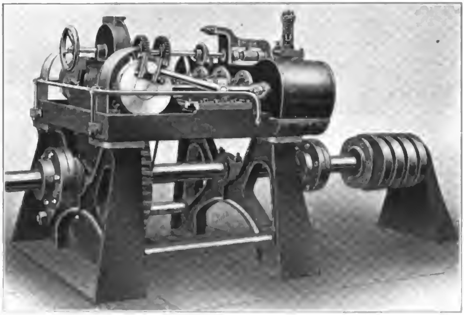


FIG. 1.—THE MCFARLANE GRAY STEAM STEERING GEAR.

Fig. 3 shows a design of the "Wilson-Pirrie" gear. In this gear a tiller is keyed to the rudder-stock, and it is connected by means of springs to a quadrant, which is free to move on the stock. Any shocks which the rudder receives must be transmitted through the springs before they reach the gearing. The steering engine is fitted with a pinion wheel, which engages with a toothed rack on the face of the quadrant.

Fig. 4 shows an alternative form of steering engine, which acts entirely through spur gearing instead of through a worm and wheel, as in the case of the engine shown in Fig. 3. A further advantage of the steering gear shown in Figs. 3 and 4 over the form shown in Fig. 2 is that, even if the gear should get out of proper alinement, due to movements in the structure of the vessel, no serious trouble will be caused, whereas when a gear, such as is shown in Fig. 2, gets out of line, the stresses on the driving pins of the rudder crosshead become very great, and the pins are apt to be broken.

A considerable leakage of steam takes place in steam steering gears when they are at rest, and in order to overcome this several devices have been employed. Fig. 5 shows the "patent economic" stop valve used by John Hastie & Company, Ltd., Greenock. The leakage of the steam is due, not so much to a badly fitting controlling valve, as to the fact that this valve does not close when the engine returns it to its

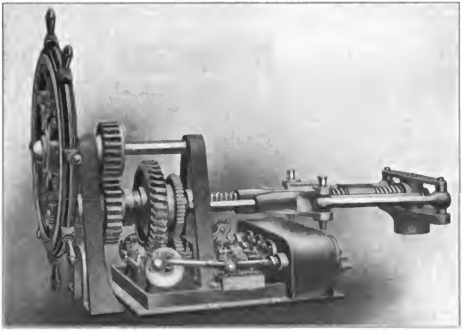


FIG. 2.—SILENT TYPE OF STEAM STEERING GEAR.

normal position. It will be readily seen that, when the valve nears the central position, it gradually cuts off the steam supply to the engine, and as the engine is operating the closing mechanism, it ceases to work when the steam supply is reduced to a certain point. The result of this is that the control valve remains open, and a blow through takes place.

The "economic" valve chest contains a valve *A* having the usual guide on the under side. Above the valve is a piston *C* of greater area than the valve, and having a small hole in it to allow the steam to pass to its top side and cause the piston to be in equilibrium. A passage *D* leads from the space on the upper side of the piston to a chest *E* containing a little slide valve *F* working over a single port. This slide valve moves in unison with the control-valve spindle of the steering engine, and opens the port, whichever way the control-valve spindle is moved.

The action of the valve is as follows: When the quartermaster on the bridge opens controlling valve *G*, simultaneously the links *H*, fixed to control-valve spindle, move, through the links *I J* and rod *K*, the slide valve *F*, which, uncovering the port *L*, allows the steam on upper side of piston *C* to escape. This destroys the balance of the piston, and the boiler steam on under side pushes up the piston, and opens the valve *A*, which allows steam to pass to the engine. Whenever the hunting gear brings the control valve back approximately to the central position the slide valve closes; the steam passing through the small hole causes equal pressure on both sides of the piston, and the spring outside the cover causes the valve to shut quickly, thus absolutely preventing any passage of steam until the wheel is again actuated by the quartermaster.

The steering engine built by Williamson Brothers' Company, Philadelphia, differs from other makes, in that the worm on the crank shaft is in halves, and that its thrust is independent. Being in halves it permits taking up the wear, and allows a quiet running of the machine throughout its life. The independent thrust prevents putting any spreading force on the

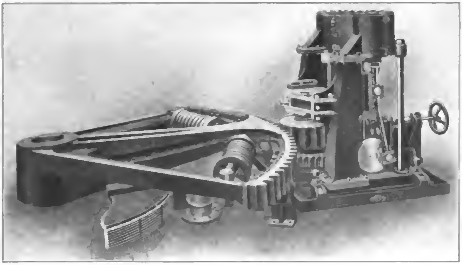


FIG. 3.—THE WILSON-PIRRIE GEAR, WITH SPRING-CUSHIONED QUADRANT.

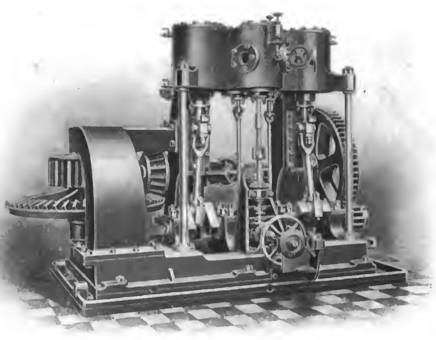


FIG. 4.—HASTIE'S STEAM STEERING GEAR, OPERATING ENTIRELY WITH SPUR GEARING.

housing, and subjects the crank shaft to only a torsional stress.

These engines are designed to control the movement of the rudder by either steam or hand, the latter being fitted only as a precaution in case of accident. In this engine the turning of a wheel on the column shaft disconnects the drum from the worm wheel, and enables the control of the rudder to be maintained through the same wheel, which, under other

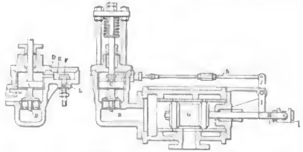


FIG. 5.—HASTIE'S PATENT ECONOMIC VALVE.

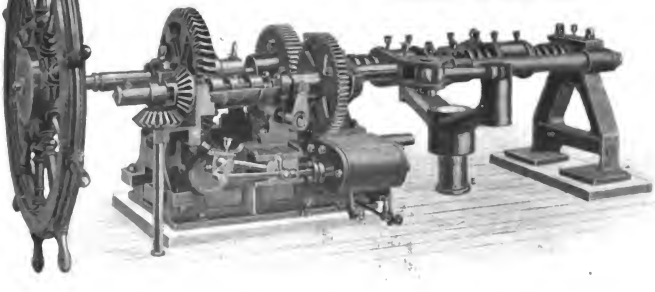


FIG. 6.—WILLIAMSON BROTHERS' COMBINED STEAM AND HAND SCREW STEERING ENGINE OF THE WORM-GEAR TYPE.

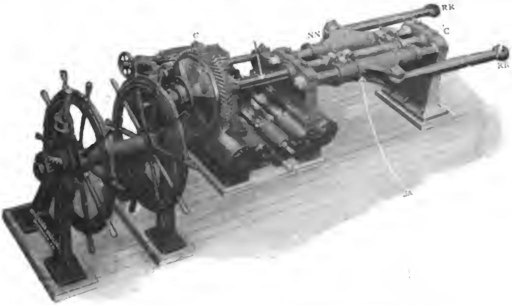


FIG. 7.—WILLIAMSON BROTHERS' STEAM AND HAND STEERING ENGINE OF THE SCREW-GEAR TYPE.

circumstances, operated the engine. The screw-gear type of this design is in use on very many battleships and cruisers in the United States navy.

The main shaft is extended beyond the machine, and is coupled to a screw, half of which is threaded right-handed and half left-handed. Two nuts on this screw are bolted to sleeves, guided by shafts, one on either side. Through pins in the sleeves and the rudder head, connections are made by links. The rotation of the screw naturally causes opposite movements of the links and turns the rudder.

To provide for any contingency which may cut off the steam supply, the screw may be operated by hand by disconnecting the clutch on the main shaft from the gear, the latter being a running fit. The two illustrations show such an engine, in one of which the rudder is entirely aft of the machine, while in the other the machine is located partly over and aft of the rudder.

The operation of a steering engine from the pilothouse is accomplished in four ways. The engine may be directly under the pilothouse, and is then operated by the extension of the shaft in the column to the gear on the automatic shaft. Again, when the engine is in its usual position aft, it may be operated through shafting and miter gears, through a wire rope, or through a hydraulic telemotor. In the latter case, the movement of the steering wheel causes a movement of the liquid from the cylinder in the pilothouse to one close to the steering engine, the piston rod of which is extended to permit connection with the automatic device for opening and closing the reverse valve.

In the Forbes steering gear (Hoboken, N. J.) the designer has departed somewhat from the generally accepted design of steering engines. The simplicity of the returning mechanism of the distributing valve is one of its principal features, this control being obtained by a worm wheel, which meshes into the worm on the crank shaft, and this worm wheel is threaded. Another departure from common practice is the use of piston valves. The vertical type here shown is particularly well adapted for the engine room, where it can be made fast to the

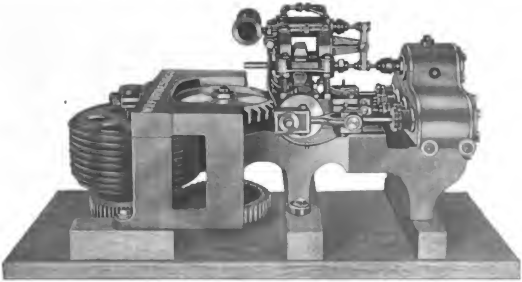


FIG. 8.—HORIZONTAL TYPE OF FORBES STEERING ENGINE, WITH DRUM FOR WIRE ROPE LEADS TO RUDDER QUADRANT.

FIG. 9.—FORBES STEERING ENGINE, VERTICAL TYPE.

bulkhead; it would seem that the proper place for a steering engine would be where it can have the proper care of the engineer. The Forbes horizontal type of gear differs from the vertical type only in the cylinders being horizontal. The illustration shows a drum fitted with wire rope, but a sprocket wheel system may be employed in place of the rope.

A feature in the Forbes gear, which is not always fitted, but which is certainly a very great advantage, is shown in the view of the horizontal gear. Here an oil tank leads to a cylinder and completely fills it on both sides of a piston, which in normal conditions is central. This piston is fitted to a rod which extends down through a stuffing-box, and is connected to a double-armed lever, the other arm being fitted to the controlling valve stem. The latter, on being turned by the trick wheel, either rises or falls, and in so doing actuates the lever. The oil in the cylinders is thus displaced, and forced through the various oil tubes to the bearings. In other words, this is an automatic system of oiling; and when the steering engine is placed aft, or in a difficult place to reach, this system is most satisfactory, and is a great oil saver.

In most designs of steam steering gears there seems to have been a misunderstanding as to the work that these engines perform. Their bearings are made small, on the assumption that the work on them is very light, and that only occasionally are they run at full speed, and then for a very short period. While the short period idea is true, observation will show that steering engines are worked almost all the time. The Forbes bearings are unusually large, and the result has been most satisfactory.

The steering columns hardly come under the heading of steering gear, although they are most important factors. One of the weak points of steering gears of to-day is the connection with the controlling column and the gear itself, which in most cases is nothing but a small wire rope. It is to be wondered that so few accidents occur from the parting of this insignificant connection between the brain which makes the ship's course and the mechanism which controls it.

A type of steering gear fitted for both hand and steam work, and so designed as to minimize the strains on the acting parts, has been developed by W. H. Harfield, London, and is illustrated by two drawings. This gear is operated by means of an eccentric pinion and corresponding quadrant, the design being such as to provide increased power as the helm is put over,

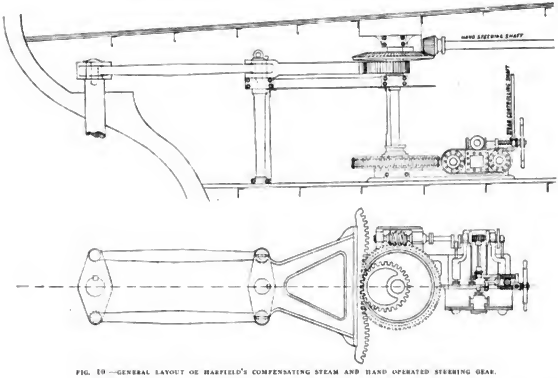


FIG. 10.—GENERAL LAYOUT OF HARFIELD'S COMPENSATING STEAM AND HAND OPERATED STEERING GEAR.

with the double result that there is quicker motion where the loads are light (thereby enabling the ship to sooner begin turning) and slower motion with increased power as the loads become greater. The bending strength of each of the teeth of the compensating rack, which is made of steel with machine-cut teeth, is above the torsional strength of the rudder head, and, as an extra precaution, there are never less than two teeth in gear with the pinion at the same time.

Tests of this gear on a large steamer showed that the stress on the links to the rudder cross-head increased almost uniformly with the angle of the rudder, from nothing at zero inclination to 70 tons at 35 degrees inclination. The stress on the teeth of the worm wheel increased from nothing at zero inclination to 4.3 tons at 35 degrees. It might be mentioned, however, that between 15 and 35 degrees the stress on these teeth was never less than 4.3, nor more than 4.7 tons, while the stress on the links increased from 22½ tons at 15 degrees to the maximum of 70 tons. The teeth on the pinion underwent

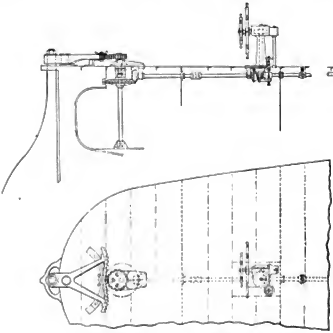


FIG. 11.—THE HARFIELD GEAR FITTED TO A TORPEDO BOAT DESTROYER.

stresses increasing from 6.22 tons at 15 degrees to 14.58 tons at 35 degrees.

Another sketch shows the application of this gear to the British torpedo boat destroyers of the river, ocean and coastal classes.

THE HYDRAULIC TELEMOTOR.

In modern steamship practice the steam steering engine is often directly attached to the rudder-head, thus doing away with chains and wire ropes leading from the steering engine, amidships, to the rudder-head, as in the older method. It is held that this arrangement obviates the danger of breaking these ropes and chains, as well as doing away with the objectionable noise. The method of operation in many cases has been by a line of shafting running in a great number of bearings, with bevel wheels and Hooke's joints where the shafting deviates from a straight line. With this method of operation, the steering wheel is very hard to work, as the friction of the gearing and shafting is considerable.

By means of the hydraulic telemotor there is practically no friction on the line of communication between the steering wheel and the steering engine, even when passing around corners in order to avoid cabins, and under decks. The telemotor, located on the bridge, is constructed of gun-metal, so as not to affect the compass, while the motor cylinder aft is of similar metal, and the pipes are of solid drawn copper, ⅜ inch to ½ inch in diameter, according to the length of the vessel.

When the apparatus is fully charged with fluid, any movement of the steering wheel and its piston will cause a corresponding movement in the piston aft, and therefore of the valve gear of the steering engine. In cold climates, 30 percent of refined glycerine is added to the fluid, which keeps the parts lubricated and resists frost to about zero Fahrenheit. A glycerometer and thermometer are provided with the telemotor equipment, so that it is possible to test the actual proportion of glycerine in the fluid at any time. It is said that water containing refined glycerine to the extent of 50 percent is safe to work at 20 degrees below zero, and with 60 percent it remains a non-freezing fluid at 30 degrees below zero.

This steam tiller and telemotor has been installed by Brown,

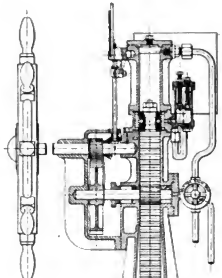


FIG. 12. SECTION THROUGH HYDRAULIC TELEMOTOR.

Brothers & Company, Ltd., Edinburgh, on the two new Cunarders *Lusitania* and *Mauretania*, as well as on the turbine steamer *Carmania*, and the *Caronia*, *Lucania* and other ocean steamers of this line operating with reciprocating engines. This device has also been installed on many of the battleships and cruisers of the British, German, Russian and Japanese navies.

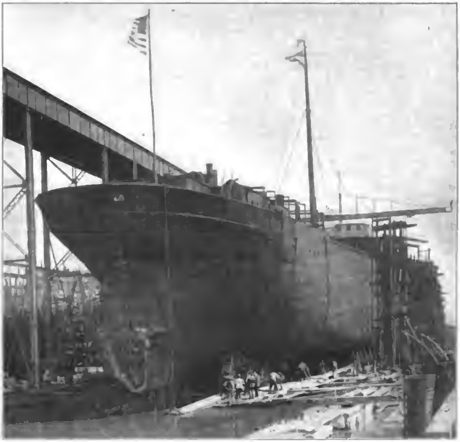
The Steamship Texas.

This oil-tank steamship was launched April 21 by the Newport News Shipbuilding & Drydock Company, Newport News, Va., for the Texas Company, New York, from plans and specifications prepared by Matteson & Drake, New York. She is of about 8,000 tons gross. Her main dimensions follow:

Length, after side of stem to after part of spar deck	410 feet
Length, after side of stem to fore side of sternpost	397 "
Molded beam	52 "
Molded depth to spar deck	30 "
Molded depth to main deck	22 " 6 inches
Sheer forward	5 " 4 "
Sheer aft	2 " 10 "

The vessel is to be schooner rigged; will be fitted with two steel masts, staysails and trysails, and three cargo booms on foremast and two on mainmast for handling general cargo. The cargo oil capacity is of 47,500 barrels crude oil; or 56,000 barrels (42 gallons) of refined oil, at a mean load draft of not over 24 feet. She is classed 1-3/3-L-1-1, spar-deck type, Bureau Veritas, and built under special survey of that society. There are two cofferdams, one aft and one amidships.

The deck machinery and outfit include one Chase Machine Company (Cleveland) 18 by 20-inch towing machine for 2¼-inch diameter steel wire hawser; a 12 by 12-inch windlass, forward; 8 by 8-inch capstan, aft; four Chase Machine Company 8 by 8-inch mooring engines; one Ford patent towing chock, besides the usual complement of bitts, chocks, etc., and steam steering gear.



STERN OF THE TANK STEAMER TEXAS, JUST BEFORE SHE WAS LAUNCHED AT NEWPORT NEWS.

She is a spar-deck type single-screw steamer, with machinery in the after end. Two continuous decks run from stem to stern, and there are a raised forecastle and bridge deck, and orlop deck in package freight hold. The hold is divided by oiltight and watertight transverse bulkheads, and an oiltight centerline bulkhead, into compartments for fourteen oil tanks, fuel-oil tanks, pump room, cargo hold forward, machinery space aft, and peak trimming tanks at ends. A continuous expansion trunk is provided between decks, with spare fuel tanks in wings. Double bottom is fitted under boiler and engine space for feed water and ballast. Space around the boilers is utilized for coal bunkers, and a cross-bunker provided forward of the boiler space. The steel bridge deck and bridge house accommodate the deck officers, with a wooden pilot house above. Officers' mess room, galley and chief engineer's and cooks' rooms are located in steel deck-house aft. Seamen and firemen, assistant cooks, oilers, pumpman, store rooms, etc., are located between decks aft.

The main engine is a vertical inverted triple-expansion, box-guide type, surface condensing, with three cranks at angles of 120 degrees. The cylinders are 27, 44 and 74 inches in diameter by 51 inches common stroke of piston. The engine is designed for maximum speed of 75 revolutions per minute. There are an independent condenser; main and auxiliary feed pumps, donkey pump, water service and sanitary pumps, fresh-water pump, circulating pump, bilge pumps, etc.; an auxiliary condenser, evaporator, feed-water heater and steam heating and fire systems.

Three single-ended Scotch return tubular boilers, 190 pounds pressure, 14 feet 3 inches inside diameter by 11 feet over heads furnish steam. Each boiler contains three Morison suspension corrugated furnaces, with heated forced-draft system, and is equipped with Rogers' boiler purifiers, the furnaces equipped for burning either oil fuel or coal, interchangeably. There is a complete electric light outfit and a searchlight. The guaranteed sea speed, loaded, is 11 knots.

NOTES ON THE FORM OF HIGH-SPEED SHIPS.*

BY A. E. LONG, M. A.

The following notes upon some of the different forms which may be used for high-speed ships are intended mainly to promote discussion upon a subject which is of interest to all designers, even if they have not had the fortune to be engaged in the design of such vessels themselves. In this connection it is also well to remember that the freak of to-day may perhaps be the orthodox vessel of to-morrow. As the subject in its entirety is much too large for a single paper, it will be well to commence by stating the limitations to the scope. The length and displacement are supposed to be already determined upon; also in a general way the curve of sectional areas; our inquiry is therefore limited to the study of the form into which the leading elements already fixed can be put. "High speed" is taken as high, relative to the length of the vessel—not merely absolute speed; thus, from this point of view, the *Mauretania* is a slow vessel, and small vessels of less than half her speed are very fast. The lower limit of speed fixed upon is $2\sqrt{L}$, and even this is much too low to bring out the true characteristics of some of the types. Elementary straight line figures of fixed length and displacement are herein used for a comparison of type, because the types are clearly differentiated, and overlapping is avoided.

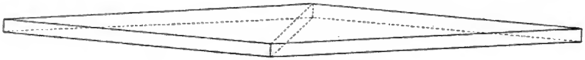


FIG. 1

In actual practice it is sometimes difficult to classify a ship as belonging definitely to one type, for vessels are in nearly all cases—except, perhaps, racing motor boats—a compromise between speed and other necessary requirements. The vessel as built is rarely the designer's ideal of a speed form, pure and simple, and is in many cases far from it. Sometimes we meet with a vessel whose designer has obviously set out with very definite ideas as to type, but in the course of his labors his heart has failed him, and relicts of older ideas appear, which are incongruous with the ideal, and really detrimental to it. In some of the compromises of type which are frequently met with, the designer has annexed much more of the defects of the two types that he has amalgamated than their virtues. A secondary advantage of these simple figures is that we can deal with the forms in the abstract, without any troublesome inquiries as to whether this is, or is not, someone's favorite design disguised.

FIVE FORMS COMPARED.

The five forms chosen, *A*, *B*, *C*, *D*, *E*, are shown in Figs. 1, 2, 3, 4, 5, and their leading elements are given in the table. For simplicity the forms are shown in quasi-perspective, and the part above water omitted.

Type A.—This comes first on our list for many reasons, among others that it is practically the only type in use for vessels of less speed than our limit, and is the only one recognized by many people as a speed form at all. Another claim is its great antiquity, as we see it in the beautiful form of the Viking ships dug up in recent times. Its intrinsic merits are also great, and it is much to be regretted that for the very high speeds with which we are dealing it is practically impossible to use it. The merits of the form, besides the value of the great experience which we have had in its use, are fairly obvious. First, it is a very easy seaboat, on account of the well balanced wedges of immersion and emersion, both in a longitudinal and a transverse direction. Secondly, the transverse sections being deep at the ends, and in practice generally sharp, there is an absence of the violent thumping shocks which occur under certain circumstances in some of the other forms. Thirdly, the wetted surface is small.

The defects are: First, the longitudinal and transverse stability are relatively small; secondly, the change of trim when driven at speeds much beyond that economical for the length is so excessive as to be prohibitive. This change of trim, moreover, is more nearly what is ordinarily known as such, namely, an actual depression of the stern and elevation of the bow, than what occurs in some of the other types, where the change of trim relative to the horizon is very largely a lifting of the fore body and a reduction in the total displacement. In small vessels which are not intended to be always run at the maximum speed, it may be possible to correct this defect by fitting a movable fin at each side of the after end, set at a slight angle to the horizontal, so as to act as a hydroplane. These fins might either be arranged to hinge up against the side when not in use, or could be fitted to slide in and out, after the manner of a sailing vessel's centerboard. Some Canadian steam yachts are fitted with contrivances of this nature, known as squatboards, but they are placed horizontally and are fixtures. The effect is said to be very marked, but from a seagoing point of view such a structure, if fixed, could have no advantage over an ordinary flat form of hull.

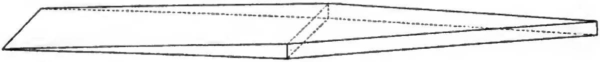


FIG. 2.

Type B.—In this type, which is practically that of all modern torpedo boats, destroyers, etc., we have the same forebody as in *A*, but a horizontal wedge is substituted for the original vertical one for the after-body. The area of the waterline is increased 50 percent, and there is a corresponding increase in the stability, both longitudinal and transverse. The wetted surface is 13 percent greater, but at high speeds it is probable that this is not really the case, owing to the vertical lift of the ship; the wave making aft is also so flat that there is less increase of surface there in contact with the water than in *A* under similar conditions.

The advantages are: First, the great increase in longitudinal and transverse stability, the latter being in small single-screw vessels a matter of vital importance, owing to the great torque of the propeller. Secondly, great reduction in the change of trim, and the fact that it is more due to a lift of the whole body than to a tipping action, as in *A*. Thirdly, the angle of delivery is much reduced with the same volume of after-body. Fourthly, the area available for accommodation is greater, and aft is of a more suitable shape for arrangement than in *A*.

The defects are: First, the wedges of immersion and emersion are badly balanced, and the necessary result is a somewhat uneasy twisting motion in a seaway. Secondly, the

* Read before the Northeast Coast Institution of Engineers and Shipbuilders, Feb. 21, 1908.

flat form of the after-body is subject to more or less violent slamming in rough weather; in the extreme case where the sections are absolutely flat this may cause serious results, unless the structure is abnormally heavy. Thirdly, variations in draft may cause considerable differences in the resistance, apart from the actual addition or reduction of displacement, as this form of after-body is really designed for one draft only.

Type C.—We now come to a type which seemingly violates all experience acquired in the past, and to most people appears to be quite new; indeed, in a paper read before the Institution of Naval Architects in 1906 it is clearly stated to be so. A little investigation of the work of the older writers on naval architecture shows that there is really nothing new in this form; it probably originated in prehistoric times from the skimming stone with which we have all been acquainted from our earliest youth. Chapman devotes part of a chapter to a discussion of the merits of two forms which are our *A* and *C*, and comes to the conclusion that *C* is excellent for smooth water speed, but impracticable for seagoing purposes. More than half a century later, Lord R. Montague, in a very interesting little treatise on naval architecture, follows on Chapman's lines, and comes to very much the same conclusion.

Some years ago, Mr. Yarrow made a series of very interesting experiments on full-sized models for international cup racers, and some of these results are available for the general good. Mr. Yarrow's conclusion seems to have been that type *C* was the best, but he modified it by cutting off the corners of the fore end, giving a somewhat uncouth resemblance to the bow of an ordinary vessel. Looking at the lines of this vessel as given in Mr. Smith's paper, read before the Institution of Naval Architects in 1906, and numerous photographs of her when running at full speed, some curious questions arise which are worth careful consideration. Roughly, about two-thirds of the forward wedge is in the air, where it is of no further use for speed, and, in fact, is detrimental, as it presents a large area for wind and waves to act upon. Mr. Yarrow has cut away about one-quarter of this. Query—Could he not have cut away a good deal more and utilized the length saved for elongating the after-body, as the total length was limited to 40 feet?

FIG. 3.

Mr. Yarrow's experiments, and the actual performance of the vessel in a very moderate seaway, completely bear out Chapman's conclusions, reached more than a century before, so that we have here another proof, if one were needed, of the great grasp of his subject which Chapman possessed.

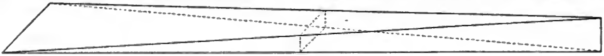


FIG. 4.

To yacht designers the form is well known, but with them its speed virtues are quite masked by the facilities which it presents for evading a length on the waterline measurement. The form itself has great merits, also great defects, and is probably one of the most interesting forms in actual use. The advantages are: First, maximum stability, both in a transverse and longitudinal direction. This merit, of course, appealed to Chapman even more than it does to us. Secondly, very fine angle for both entrance and delivery. Thirdly, maximum room on the lower deck, and of a shape well adapted for arrangement of cabins, etc.

The disadvantages are: First, great change of apparent trim; but this is quite different from the case of *A*, as it is chiefly a bodily lift of the vessel, not merely a tipping about the center, as in ordinary ships. Secondly, the slamming action in a seaway at both ends may be very violent, and a vessel of this type will require to have scantlings much in excess of those calculated in the usual way. Thirdly, the wetted surface, as will be seen in the table, is 26 percent larger than that of *A*, but this is really of little importance for high speeds, as, owing to the bodily lift, the surface is actually considerably less than that given for the still-water condition. As regards the angles given, there is also in actual work a great difference from the "at rest" condition. Forward, the angle will be greater, but a very large portion of the body there is above water; aft, the surface of the bottom will be nearly or quite horizontal, giving practically no angle, merely frictional resistance.

Type D.—We have here another curious form which at first sight appears to be of very recent invention; but, as in the case of *C*, the origin is probably old. An instance of it in a fairly pronounced form is seen in the Northeast Coast coble. Yachtsmen have also been familiar with it for many years in the well-known "raking midship section;" in fact, this is the raking section carried to its logical conclusion In this type in the table the breadth has been increased, also the draft at center; for, if the breadth had been retained, the draft required would have been too great. As shown in the table, the coefficients also differ, the block being less and the prismatic more. The curve of sectional areas is a common parabola, being thus rather fuller than is generally found in ordinary forms. In practice the curve would probably be rather finer at the ends, as the fore foot would be somewhat rounded off, and the keel line right aft slightly hollowed, coupled with a possible rounding off of the corners of the waterline. As this type is really a further development of *B*, its merits and defects are much the same in character, but accentuated. As to accommodation, the fore end is too fine to be of much use, and the after end inconvenient in shape. The wetted surface is not quite so large as that of *C*, but when running at high speeds it is probably larger, as this is a type not intended to lift much forward. The transverse and longitudinal stability are not satisfactory, considering the large increase of breadth.

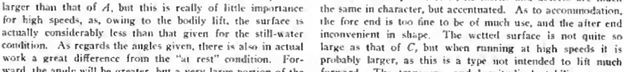


FIG. 5.

In a seaway, such a vessel would almost certainly be very wet and uncomfortable, and in some conditions dangerous.

The case of the coble, however, shows that, modified, a good sea boat may result, at least in small sizes; whether a large coble would be a desirable vessel is open to question. The great difficulty in docking a large craft having such a profile, unless she had considerable additions in the way of dead-wood, etc., is obvious. The French motor boats of this type seem to behave fairly well in the rather mild type of sea in which they have recently been tried, being superior to the rival type *C* in this respect.

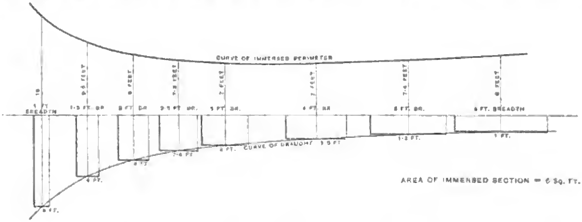


FIG. 6

Type E.—This is one of the forms of hydroplane which has been so much before the public in the last few years. Curiously enough, the sketch would do equally well as representing some of the most recent designs published, or the model submitted to the Admiralty nearly forty years ago by the Rev. C. M. Ramus, so that there does not seem to have been much progress made in this direction, so far as form goes. The power to drive it is, of course, another question. The late Mr. William Froude's report upon the trials of this, and a revised model of his own, and the articles which were written on the subject in *Naval Science* and *The Annual of the School of Naval Architecture*, afford very interesting reading. They are wholly condemnatory, but the idea still lives on, so that perhaps the reverend gentleman was nearer to the mark than his critics imagined.

It is very difficult to compare this form with the other four, as they are more or less accomplished facts, whereas this is still in a very nebulous state. Startling stories are abroad as to what can be done with one of these craft of amazingly small dimensions, but there is a painful absence of reliable facts and figures. The first thing that will strike anyone looking at the published drawings is that, even if a great bodily lift took place, there would still be a very serious eddy making behind the ends of the planes. Possibly this can be got over in time, but at present it seems to be a grave defect. As a seaboat there does not appear to be much hope of improvement. Mr. Froude gave a startling description of what would happen to a semi-flying Atlantic liner among waves. Some mechanical genius may come forward who can deal with the shocks to the structure from such usage, without taking excessive weight; and it must be remembered that light weight for the dimensions is an essential feature of the problem.

In concluding this part of the subject, the relative value of the five forms for very high speeds, so far as they have yet been tried, may be briefly noted. *A* may be summarily struck out, both on theoretical and practical grounds. *B* is the form in general use for torpedo boat destroyers, torpedo boats and many small craft in which high speed is not the only object sought; it is, in fact, the only one of the five which as yet meets the usual requirements and has been thoroughly tested practically. *C* and *D* are the rival forms for motor boats; which may be taken as possible models for the ships of the future, when we can get the power to drive them. In practice, *D* seems to have rather the advantage over *C* in ordinary working conditions of weather. Under what may be called tank conditions, their respective merits are still very doubtful. *E* is not yet in a sufficiently practicable condition to judge of its ultimate success or failure.

In all the forms dealt with, when driven at very high speeds, some curious phenomena occur. We see a vessel in a position not momentary, but for hours together, where the center of gravity is many feet ahead of her nominal center of buoyancy, and if of one of the flat-tailed types, she has also considerably less displacement than her total weight. In the case of *E*, and also, though in a less degree, of *C*, this latter feature is intentional, and we are met with the difficult problem as to whether it is better to use a considerable part of our available

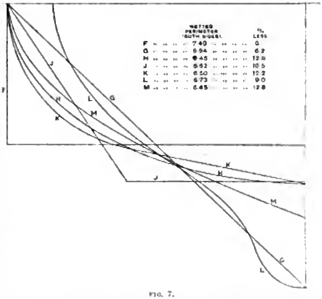


FIG. 7.

power in lifting the vessel, or to use it for driving through the water in the ordinary manner, as aimed at in *D*. That we cannot get the lift without expenditure of power is fairly obvious. If the lift causes a considerable change of trim there must also be a corresponding loss in power, owing to the angle of the shaft with the horizontal being increased, and as the shafts of all, or nearly all, high-speed vessels are already at a considerable angle, this loss alone may be serious. In *E* there is supposed to be no change of trim; in fact, this is one of the chief objects of using two or more inclined planes, but

this advantage involves serious disadvantages, at least in the crude shapes which have yet been tried. Whether or no this form can ever come into even limited use is still very doubtful.

FORM OF THE MIDSHIP SECTION.

As the shape of the midship section generally governs the form of the other sections for a considerable portion of the vessel's length, the consideration of it is important, and the following notes may be useful for discussion. In the previous part of this paper the mid section was taken as being in all cases a rectangle, whereas there is really a very large number of suitable forms to select from, particularly if the dimensions may be varied while keeping the given area. Even with the rectangle itself, the wetted perimeter may be greatly altered by varying the ratio of breadth to depth. Fig. 6 illustrates this. The areas of the sections are all alike, but the perimeter changes from 13 feet at one end to 8 feet at the other. The curve shows the wetted perimeter to a scale half that of the sections themselves. From the surface point of view, the very shallow section is considerably better than the very deep one, but the minimum is found in a moderate proportion. If, however, we also consider the wave-making resistance, we know from Rota's and other experiments that within the limits of the experiments the deeper sections yield less resistance, so much so as to overbalance the greater frictional resistance. This difference will naturally increase as we increase the speed, but there will possibly come a speed where the shallow section will, owing to its skimming action, give a less resistance than the deep.

Fig. 7 shows some of the forms which have been adopted, or proposed, all being of the same area. Section *F* does not seem to have any advantages to compensate for its large relative girth, unless there are reasons for strictly limiting the dimensions; when something approaching a rectangle may allow us to use a curve of sectional areas which would otherwise be impossible. *G* is merely the ultimate development of the rising floor, which has been a favorite feature in design in many countries and many ages. It has considerably less girth than the rectangle, but is not an economical section from the surface point of view. It involves large dimensions, and in many cases an undesirable draft. In America this is a favorite type, as will be found by a study of the many published designs, but the reason for the preference is not very clear. The resulting water, ribbon and buttock lines are very clean, easy curves, and the vertical sections of the vessel forward being sharp, there is not so much hammering in a seaway as in the flatter-bottomed types.

H is a true semi-ellipse, which has the great advantage of having a small girth for the given area and compact dimensions, and it lends itself very well to development into any of our forms *A*, *B*, *C*, etc. For example, in a form of *D* type, by using the elliptical sections we can gradually merge from a vertical line forward to a horizontal line right aft without abrupt changes in the horizontal lines. An objection which may be made to the true semi-ellipse is that to many people's eyes it is too lean under the bilge, and too full about the center line. Perhaps for this reason the true curve is not often met with; a very good example of its use will, however, be found in the launch *Lotus*, the lines of which appear in the *Yachtsman* of Dec. 19, 1907. *K* is a modified section which gets over this objection, but the girth has to be made somewhat greater. The section shown is constructed by describing a circular arc with a radius of one-quarter the breadth of the vessel for the bilge, and striking a tangent in from this to the center line, to inclose the required area. It is not suggested that this construction has any particular merits; it is merely given as fairly representing many sections in general use. *J*, called in America the sharpie or dory type, has been introduced here, and it crops up from time to time as having some more or less occult virtues. It yields a moderately small girth, and lends itself fairly well for use in all the forms.

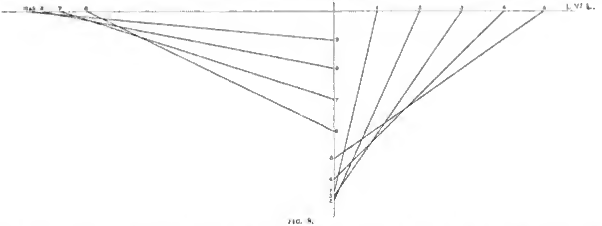


FIG. 8.

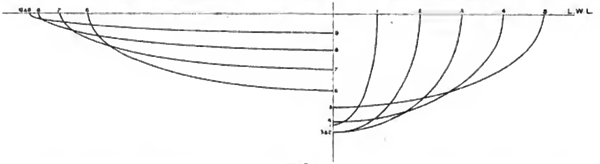


FIG. 9.

TABLE OF ELEMENTS.

Dimensions in Feet.	*A*	*B*	*C*	*D*	*E*
Length on waterline	50	50	50	50	50
Breadth, molded	5.	5	5	6	5
Draft at center of length	1.2	1.2	1.2	1.5	1.2
Draft, maximum	1.2	1.2	1.2	3.	1.2
Displacement in cubic feet	150	150	150	150	150
Center of buoyancy below waterline	0.60	0.50	0.40	0.75	0.40
Transverse metacenter above center of buoyancy. B.M.	0.87	2.17	3.46	1.50	3.46
Longitudinal metacenter above center of buoyancy. L.M.	87.15	178.68	347.22	140.54	347.22
Area of waterline	125	187.5	250.	150	250.
Area of wetted surface:					
Sides	120.57	90.28	60	150.26	72.
Bottom	125	187.60	250.20	150.26	250.20
Total	245.57	277.88	310.20	300.62	322.20
Area of wetted midship section	6	6.	6	4.5	....
Angle of entrance	11° 30′	11° 30′	2° 45′	6° 52′	2° 45′
Angle of delivery	11° 30′	2° 45′	2° 45′	3° 20′	2° 55′
Excess area of wetted surface over *A*	0	13%	26%	22%	31%
Block coefficient, using depth at center	0.500	0.500	0.500	0.333	..
Prismatic coefficient	0.500	0.500	0.500	0.667	....
Breadth to give the same *BM* as *B*	6.78	5.00	4.27	6.78	4.27

M is formed of two semi-parabolas base to base. Very much the same remarks apply to this as to the semi-ellipse. The curve is a pleasing one and well adapted for use with such of our types as have deep fore-bodies. Sections *G*, *H* and *M* have the common disadvantage in that they are rather cramped for room in way of the wing shafts in multiple screw vessels, and the shafts may be an inconvenient length out board. A good deal might be written about the relative strength of these forms of midship section, but we have here dealt with them from a speed point only.

Figs. 8 and 9 are given to show how, with a fixed length, displacement, curve of sectional areas and form of load waterline, we may greatly vary the cross-sectional shape. Fig. 8 is of the triangular section form known in America as the Dolphin type. Fig. 9 has true semi-elliptical sections all fore and aft.

The sections like those given, which are mechanically constructed, such as the rectangle, triangle, ellipse, parabola, etc., are not suggested as necessarily superior to curves drawn in the usual way to suit the eye, but there is some advantage in using a constant type of curve right fore and aft, as it insures an amount of harmony between the sections which is not always found in forms constructed without it, even with good curves of sectional areas. Abrupt changes in sectional shape are common features in poor designs, and should be avoided where possible.

In conclusion, the writer wishes again to state that these notes upon the forms possible for high-speed vessels have been written mainly to promote discussion upon a subject which has not previously been before the Institution. The forms shown are at present of very limited application, such as to torpedo craft and racing motor boats, but unless the dimensions of ships can keep pace with the increased demand for speed, some such forms as these must ultimately be adopted instead of our present big ship type. Possibly in the course of the discussion our attention may be drawn to some form which is superior to any of those shown, and if that is so, then the writer will have done the Institution a good service, and have been well repaid for his efforts.

LAUNCHING OF THE GERMAN SURVEYING SHIP PLANET.

L is a very interesting section, patented by the great French designer, the late M. Normand, from whose specification it will be seen that the object sought is twofold—a reduction of breadth for the same metacentric height, and a lowering of the machinery—single screw—so as to get the shaft horizontal. The girth is large, but as the lower part of the section is merely a sort of crank-pit not more than half the vessel's length, the end sections are relatively more cut away than in the other types. A somewhat similar section is found in the very curious design *Napier*, given in Mr. J. A. Smith's paper read before the Institution of Naval Architects in 1906. In this an attempt seems to have been made to combine type *A* with a flat stern. The main body of the vessel is a pure type *A* with very fine waterlines, the length being about three-fourths of the total. On the after part of this is superimposed a flat-bottomed body of very little depth, which projects far enough aft to make up the total length, 40 feet. The vessel does not seem to have been very successful, but this may be due to other causes than the peculiar form of hull

A German Surveying Ship.

The surveying ship *Planet* was recently constructed for the German navy, and is intended to replace the old vessel formerly used by that navy in connection with surveying work. The new vessel embodies all improvements of modern ship building, and is equipped with the most up-to-date scientific instruments. Eight watertight transverse bulkheads and a double bottom have been provided to increase her safety. The vessel is made from first-class ship-building steel, and, like mercantile ships, has a round stern and a yacht-shaped stern post. To the foremast is fitted a crow's nest, serving as outlook.

The rooms of the ship are exceptionally high and well aerated, as she is to be temporarily used in tropical climates; a satisfactory insulation from the outside steel hull has likewise been secured. All the apartments of the vessel are furnished according to general regulations by the German navy, except that the walls and furniture are made of wood instead of sheet iron, as in the case of warships, so as to increase the comfort afforded by the ship.

STERN OF SURVEYING SHIP PLANET, SHOWING FITTING OUT UNDER WAY AND NEAR COMPLETION.

The rearmost deck house contains a large drafting room, with files and instrument room, as well as a living room for a scientific assistant. In front of the latter, between the engine and boiler casings, there is situated the crew's galley. The four front deck houses are used, respectively as commander's room, rudder engine room, room for hammocks, oilskins and cleaning utensils, and as lavatory.

The ship is lighted by electricity, for which a direct-current dynamo for 110 volts has been installed in the engine room. In order to use the ship as well in cold climates, all the working and living rooms have been provided with steam heat. Two motor boats, 10 meters (32.8 feet) in length, have been provided in order to assist in the surveying work to be performed by the vessel; these are the first motor boats ever used on board a ship of the German navy. In addition to these, there are two whale boats and another rowing boat on board.

The ship has been equipped with means of investigating the higher strata of the atmosphere. To this effect there are used both kites and balloons. The former, which are equipped with meteorograph and anemometer, are able to rise to a height of about 5,000 meters (3 miles), and serve to measure the atmospheric pressure, temperature, moisture and speed of wind, as well as the direction of the latter.

The balloons are used in connection with investigations of the higher atmospheric strata up to 14,000 meters (8⅝ miles). Two balloons are tied together, carrying underneath a float. One of the balloons is filled with a greater amount of gas than the other, the amount depending upon the height to be reached. At a given height this balloon will explode, and the other, being unable by itself to carry the float and accessories, will drop to the earth (or sea), maintaining itself above water by means of the float for some time, until it is taken on board a boat.

As regards the oceanographical work to be performed by the *Planet*, researches on the temperature and salt contents of the water, as well as on the condition and shape of the bottom of the sea, should be mentioned. To this effect there have been installed on the upper deck a drum and two sounding machines, one of which had been used already on board the *Valdivia*. Among other researches should be mentioned stere-photogrammetrical records of the waves of the sea and the shape of the coasts. To this effect the vessel has been provided with two photo-theodolites, placed on supports at a distance as great as possible on the upper deck.

In order to test all the scientific instruments, two trips were undertaken from Kiel, one of which was confined to the western part of the Baltic. This was intended to test the balloons and kites. The other trip was directed through the

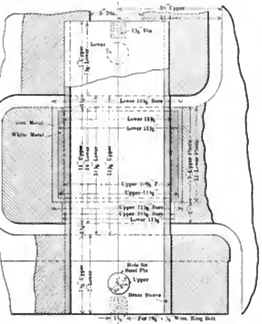
Belt around Skagen, to the North Sea and back through the North Sea-Baltic canal, it being intended to sail towards the Norwegian channel, comprising depths of up to 800 meters (437 fathoms), in order there to test the sounding and water-raising outfits.

The propelling machinery includes two three-cylinder triple-expansion engines of an aggregate output of 350 indicated horsepower, the speed obtained by the vessel being 10½ knots.

A FEW CONSTRUCTIVE DETAILS.

RUDDER STOCKS AND PINTLES.

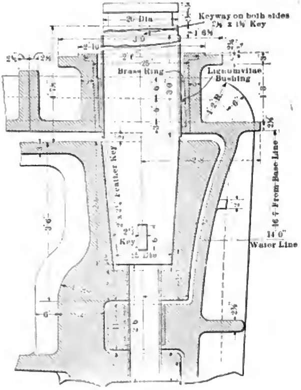
A view is given of the upper and lower rudder pintles of the battleship *Ohio*, the drawing being that made for the upper pintle. The pintles are of wrought steel, and in the rudder frame run in a gunmetal bushing lined with white metal in eleven sections ⅝ inch apart at the inside edge and dovetailed into the bushing. The pintle itself has a diameter of 9 inches upper and 10 inches lower, and is fitted with a brass sleeve having a diameter in the bushing of 10 inches upper and 11 inches lower. The upper and lower diameters



RUDDER PINTLES FOR BATTLESHIP OHIO.

of the sleeve in the upper part of the pintle are respectively 9⅞ and 11⅛ inches. In the lower part of the pintle, the upper and lower diameters of the sleeve are respectively 10⅛ and 10⅞ inches. The total height or length of the upper pintle is 28 inches; of the lower, 31 inches. Both are finished all over.

The rudder stock for the armored cruiser *California* has a net diameter of 20 inches, and is made of wrought iron finished all over. The brass sleeve through the watertight gland is 21 inches in diameter and 3 feet long. It is shrunk on to the stock. The lower end of the stock is tapered from the normal 20-inch diameter to a diameter of 15 inches at the bottom. This taper covers a length of 2 feet 9 inches. A keyway fitted the length of the taper takes a key measuring 2 by 2¼ inches, which is arranged for rigidly fastening the stock to the rudder frame. The brass sleeve runs in a lignum vitae bushing fitted in the brass-lined gland above mentioned. The upper pintle of this rudder is given in the same drawing as the rudder stock, and is seen to have a net diameter of 8 inches and a diameter of 9 inches over the brass sleeve, which is shrunk on. The length of the pintle is 2 feet 6 inches. In

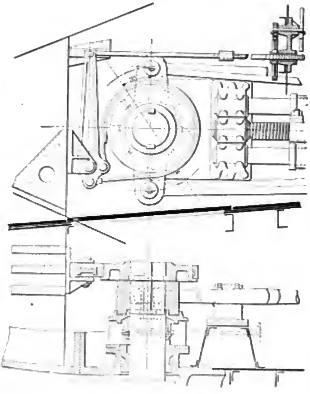


RUDDER STOCK ON ARMORED CRUISER CALIFORNIA.

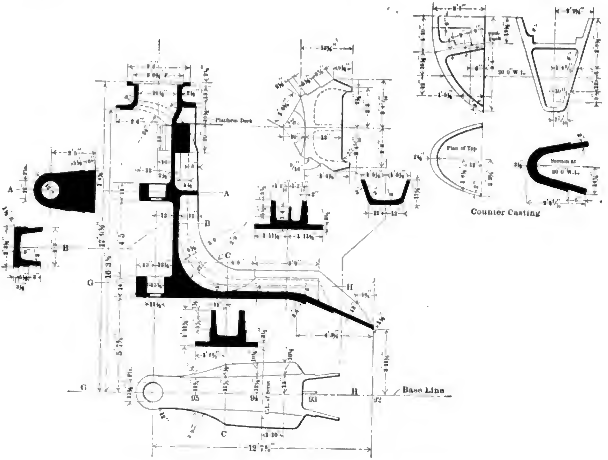
the cast steel stern frame this pintle turns within a white metal bushing of a maximum diameter of 11 inches.

STEERING GEAR FRICTION BRAKE.

The drawing shows the location of the rudder head below



FRICTION-BRAKE DETAILS FOR STEERING GEAR.



DETAILS OF THE CAST-STEEL STERN POST AND COUNTER CASTING ON THE BATTLESHIP OHIO.

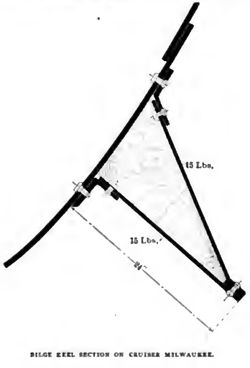
the protective deck of a naval vessel, this being a standard type for large warships in the United States navy. The friction brake is of the ordinary strap or band variety, and is in contact with a friction wheel on the rudder head over a total of 235 degrees. The brake is operated on the usual lever basis, with a long lever arm for the application of the power, and short lever arms for the tightening of the band around the friction wheel. The friction wheel and the lever arm are of cast steel. The feather keys, the friction band, and the friction band lever shaft are of wrought steel. The friction band is lined with wood; the gears and head wheel are of gunmetal; the gear bearing and the lever bracket may be made at will of cast steel or brass.

STERN POST AND COUNTER CASTING.

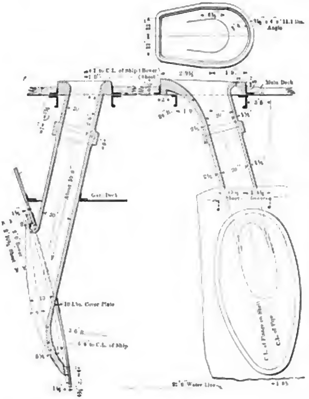
The drawing represents details from the battleship *Ohio*, the weight of the stern post being 23,052 pounds, and of the counter casting 3,900 pounds. The drawing gives all the necessary details.

BILGE KEEL OF THE CRUISER MILWAUKEE.

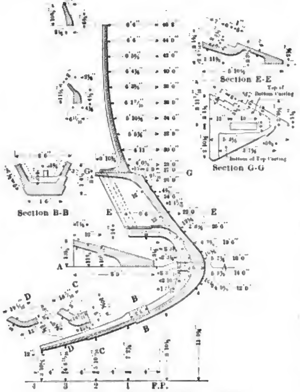
The drawing shows this bilge keel, which projects 24 inches from the skin plating of the ship, and is made up of two 15-pound plates, with a flat bar at the outer edge, measuring 3 by ¾ inches. Between the two plates is a filling of Oregon pine, the plates being fastened to the ship by angles measuring 4 by 4 inches by 12.8 pounds. Connection between the angles and the plates is by ¾-inch rivets, and between the angles and the shell plating are ⅞-inch rivets, the spacing in each case being 3¾ inches center to center. The outer bar is connected to the plates by ¾-inch rivets spaced 3 inches between centers. Canvas and red lead are placed between angles and the shell plating of the ship. The outer lower



BILGE KEEL SECTION ON CRUISER MILWAUKEE.


HAWSE PIPES OF SEMI-ARMORED CRUISER MILWAUKEE.

point of the bilge keel amidships is 3 feet 2½ inches above the bottom of the keel, and 3 feet 11¼ inches inside the molded line of the frames at waterline. The lower plate prolonged to this molded line intersects it at a point 5 11/16 inches above the bottom of the keel.



STEM AND RAM CASTINGS OF BATTLESHIP OHIO.

HAWSE PIPES OF THE CRUISER MILWAUKEE.

The drawing shows the cast-steel hawse pipes for bower and sheet anchors, they being used with 2½-inch stud link chain. The pipes are of cast steel, in two pieces each, the upper section weighing 3,397 pounds for bower anchors and 3,469 pounds for sheet anchors. The lower sections weigh 9,791 pounds for bower anchors and 10,205 pounds for sheet anchors. Detailed dimensions, etc., are shown on the drawing.

STEM OF THE BATTLESHIP OHIO.

The stem of this battleship is made up of three steel castings, with offsets and dimensions as shown on the drawing. The total weight is 54,630 pounds, of which the middle casting, weighing 40,250 pounds, accounts for by far the larger portion. The upper casting weighs 6,230 pounds, and the lower, 8,150 pounds. The forward perpendicular of this ship is located on the 23-foot 6-inch waterline. The depth of the casting at this point is 14 feet 7½ inches, this being the draft on the forward perpendicular. The lower edge of the casting on this perpendicular is 8 feet 10½ inches above the base line of the ship. The forward point of the ram is 5 feet 9 7/16 inches forward of this perpendicular, the thickness of the casting and rib at this point being 3 feet 6 inches. The casting proper has a fore-and-aft thickness of 16½ inches, with section as shown.

The Steam Towing Launch Lautaro.

This vessel has a length of 55 feet 6 inches, a beam of 10 feet 9 inches, and a draft of 4 feet. She was designed and constructed by Edward Hayes, Watling Works, Stony Stratford, for work in Chile in connection with the customs duty. The hull is built of special mild steel in four strakes, varying in thickness from ¼ to 3/16 inch. The frames are of angle steel. Three bulkheads divide the hull into four compartments. Forward of the collision bulkhead the space is given up to anchor-chain locker. The next section is the saloon, next is the machinery space, aft is a cabin for the crew.


THE CHILEAN CUSTOMS LAUNCH LAUTARO.

The saloon has seats upholstered in blue with teak edgings, a large folding teak table, lockers, cupboards, brass scuttle lights, a large skylight of teak finished with green figured glass and brass protection rods, and is supplied with a small steam-heated copper water boiler for use in preparing coffee. Aft of the saloon is a lavatory, on the port side, and on the starboard a stairway leading through a teak companionway to the deck.

In the machinery space is a boiler of the marine return tube type, working under a pressure of 120 pounds per square inch, and a compound surface condensing engine for operating the propeller. Cold air is brought to the furnace by two large cowls, a teak engine-room skylight and steel stokehold grating. Hot air is extracted from over the boiler through a steel casing arranged for natural ventilation.

The propelling engine is of the double-balanced crank type, with cylinders 8 and 16 inches in diameter, and a stroke of 10 inches. All wearing surfaces are extra large and automatically lubricated, and the engine is designed for continuous hard work at full speed. The condenser has a large cooling surface, due to the fact that the circulating water available will be of relatively high temperature. The air, circulating, bilge and feed pumps are fitted on the port side of the engine, and worked from the low-pressure cylinder by long, rocking levers. It is said that the engine works very smoothly, and with little vibration.

The shafting is in two pieces, of Siemens-Martin mild steel, with solid couplings. The thrust bearing has seven rings, and is of the horseshoe type, running in oil bath. Plummer blocks are also fitted. The stern tube is lined with white metal for long distances at both ends, and fitted with an internal brass gland. The propeller is of hard cast iron, with three blades. A powerful fire and salvage pump is fitted in the engine room, with deck connections for suction and delivery hose. A supplementary steam boiler feed pump is also fitted in the engine room, as well as a steam ejector.

The cabin for the crew is fitted with seats suitable for bunks, a table, lockers, and a cooking apparatus heated with steam from the main boiler. A canvas awning extends almost the whole length of the vessel, being supported by galvanized hand rail and stanchions. There is a powerful patent slip hook with disconnecting gear, towing bits, a large teak shelter for the customs officers, and a steering wheel of brass-bound teak on weather-proof standard. A small winch is fitted forforward for raising the folding anchor.

Horsepower of Auxiliary Machinery.

The Editor INTERNATIONAL MARINE ENGINEERING:

Some years ago I had occasion to work out the relative power developed by main and auxiliary engines, in order to keep separate accounts of power developed, and steam and coal used, of main and auxiliary machinery. The result, I think, is a fair average for transatlantic liners under ordinary working conditions. Owing to the great variation in speed and fluctuations of load, it is practically impossible to obtain an absolutely correct average of the power developed by some auxiliaries, since most of them, especially the pumps, are not fitted with indicator attachments, and the mean effective pressures in the cylinders must be assumed. In some of these cases it is more accurate to calculate the work done and power developed (in the pumps) by the displacement of the water piston and the pressure heads against which water is delivered, due allowance being made for friction and pump efficiency. With the electric plant the power developed can be determined from the current output in amperes and the potential, due allowance here being made for friction of engine.

In the test in question the twin-screw propelling engines developed 20,446 indicated horsepower. This included the air pumps, which were attached to the main engines. The principal other auxiliaries to these engines were as follows:

	Horsepower.
12 forced-draft fans for main boilers	652
1 forced-draft fan for donkey boiler	23.6
3 fans for engine-room ventilation	38.7
4 circulating pumps for main condensers	96.5
1 circulating pump for auxiliary condenser	3.3
2 main feed pumps	105.6
2 hot-well pumps	28.2
1 donkey boiler feed pump	4.1
	952

The electric plant included six dynamo engines, as follows:

	Horsepower.
3 for lighting, and ventilating fans in saloons	91.5
2 for ventilating fans in fire rooms	44.7
1 for operating ammonia compressor fans	14.1
	150.3

The other auxiliaries included:

	Horsepower.
2 engines for driving ammonia compressors	28.5
2 hydraulic pumps for steering and working elevators	33.9
3 evaporator feed pumps	2.1
2 bilge pumps	4.8
2 sanitary pumps	3.7
3 fresh-water pumps	1.3
3 brine pumps for refrigerating plant	5.5
2 circulating pumps for refrigerating plant	2.8
1 ballast tank pump	16.3
	98.9

This makes a grand total of 1,201.2 indicated horsepower for auxiliary machinery. Omitting the ballast tank pump, which would be used only very occasionally, we find that the balance of 1,184.9 horsepower is 5.79 percent of the horsepower of the main engines.

During a trip across the Atlantic, the average quantity of South Welsh and Eureka coal consumed per hour for all purposes was estimated at 31,733 pounds, on the basis of the amount on hand at beginning and end of voyage. This represents 1.55 pounds per indicated horsepower per hour as developed by the main engines. The consumption of steam, calculated from indicator diagrams of main engines, was 13.6 pounds per hour per horsepower, to which 20 percent was added for condensation, making 16.3 pounds, or a total of 333,270 pounds of steam per hour.

The steam used by the dynamo engines at 25 pounds per horsepower hour (with 150.3 horsepower) was 3,757 pounds. The fans and circulating engines, 842.6 horsepower at 35 pounds per unit, used 29,491 pounds of steam. The pumps, 192 horsepower at 85 pounds per unit, used 16,320 pounds of steam. The evaporators, in making up feed water, used 14,880 pounds of steam. This makes a total of 64,448 pounds of steam, or 8,056 pounds of coal on the basis of 8 pounds of steam per pound of coal. Deducting this from the total coal consumption per hour, we have 23,677 pounds for the main engines, or only 1.158 pounds per indicated horsepower per hour.

H. J. TEIFER.

A Patent Oil Firing System.

BY A. K. FISHER.

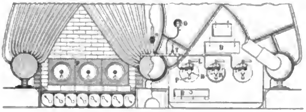
The great success attending the trials of the British destroyers of the *Mohawk* class has attracted attention to the subject of oil fuel, which is understood to have been largely responsible for the extreme power and speed developed by these vessels. The development of oil firing on steamships seems to have entirely demonstrated the superiority of the mechanical burner as compared with systems using steam or compressed air for atomizing liquid fuel. The system

(Koerting) under consideration, however, adds to the mechanical feature the physical effect of atomizing. This gives a still better result in service. The inventor is Ernest Koerting, Hanover, Germany.

The handling of the oil for taking it on board, storing and transferring it from the various tanks is taken care of by an independent pumping and piping system. This arrangement provides proper pumps to handle the oil with a pipe system as simple as possible through manifold arrangement, and to supply the oil to the settling tanks.

From the settling or service tanks the oil is supplied to the burners; the main object of these settling tanks is to separate the oil from water which it may hold in suspension. The tanks are equipped with diaphragms to prevent the water, after being separated, from again mixing with the oil in consequence of the motion of the steamer. The oil is taken from the settling tanks at a distance of one-fourth of the height of the tank from the bottom, so as not to take in the water and impurities; cocks being provided on the bottom of the service tank to drain off the water.

The suction heaters are usually placed in the settling tank, which consists of a steam coil of proper size surrounding or near the suction pipe. The oil is now drawn through the suction filter by pump, and forced through pressure filter, pressure heaters and to the Koerting burners in front of the boiler. The temperature of the oil when leaving the suction heater will be from 90 to 100 degrees F., and in the pressure heater



BOILER ARRANGED FOR EXCLUSIVE OIL FIRING.

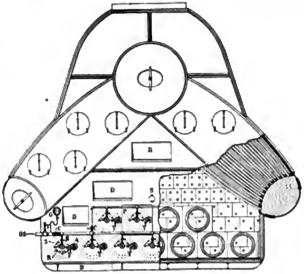
it is heated up to 260 degrees F. Evaporation is prevented by having the oil under a higher pressure than corresponds to the above-named temperature.

The central outfit is usually combined in one place in each boiler room, for reasons of simplicity of piping. The pump may be either of the horizontal or vertical type, according to conditions. The heaters are placed either vertically or horizontally, but always with a view of having easy access to the piping. The piping arrangement inside the central outfit gives the possibility to use either of the duplex filters, heaters or pumps, according to convenience and necessity.

The piping system contains also other appliances for safety and measuring, that is, safety valve to act in ease of excess of pressure in the oil line; gages to indicate the pressure of steam and oil; and thermometer to show the temperature. The steam pressure in the steam pumps and in the heaters is kept constant by one main reducing valve.

The Koerting burners are arranged in front of the boiler, as shown by cut; each burner spraying usually 300 to 400 pounds of oil per hour at 100 pounds pressure. The burners are fastened to the front plate of the boiler by means of a sliding door, which admits of removing the burner for cleaning or replacing.

To burn one pound of oil, there is required 200 cubic feet of air, and this air is admitted to the burner by means of a cylindrical air register, which permits of an exact regulation of the quantity of air required for combustion. The air registers are sometimes, if space permits, arranged with blades to give the air a rotary motion to assist the proper mixing of oil and air.

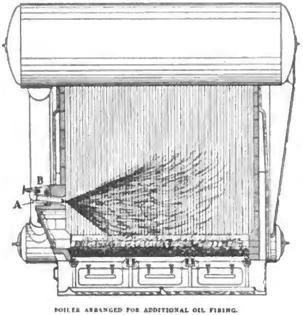


BOILER ARRANGED FOR EXCLUSIVE OIL FIRING.

To further compel the air requisite for combustion to intimately mix with the oil, fire-brick cylinders are installed. This arrangement forces the air to surround the injected oil and to reach a proper contact between air and the fuel for combustion. This network of fire-clay acts also as a heat accumulator, and helps to keep the furnace at a high temperature. Where no donkey boilers are installed, some of the burners on each boiler are equipped with a heating coil to heat oil in starting up, and a hand pump is furnished for keeping up oil pressure until enough steam is available for running service pumps.

The system is used in two ways, the first of which is known as "exclusive" oil firing, where nothing but oil is used as fuel; while in "additional" oil firing, oil is used to supplement the burning of coal, and is particularly available for getting up steam rapidly, or for high forcing where the coal used would give merely a normal operation. The types of apparatus are naturally quite different in these two cases.

The cut showing the application of the system for exclusive oil firing gives the arrangement as fitted to a watertube boiler



BOILER ARRANGED FOR ADDITIONAL OIL FIRING.

of the Thornycroft, Schultz, Yarrow, Mosher, Normand or White-Forster type. In the illustration, six burners are fitted at *B*, air entrance being provided below and above them at *D*. Each burner is located in a fire-brick cylinder *F*, and is equipped with an eyeglass *P*, for observing the action, and air register *R*. The handle *L* is designed for regulating the entrance of air. Oil supply is furnished through the pipe *S*, and a gage at *G* and thermometer at *T* are used for observing the pressure and temperature under which the oil is fed. (In the larger cut, the oil supply is at *OS;* the observation holes at *S;* the hand wheels for regulating air supply at *A;* and the cocks for regulating oil supply at *C.*)

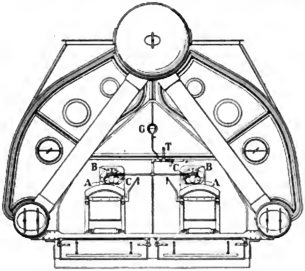
The drawing is from an installation on a British torpedo boat, and may be compared with other similar installations in the following table, where *A* represents the torpedo boat in question, *T* represents the *Tartar* of the British navy, *M* is the *Mohawk* (the *Cossack* is similar) and *S* is a German torpedo boat of the "*S*" type.

	A	*T*	*M*	*S*
Heating surface (*a*) (*b*).........	4,478	5,300	4,931	6,350
Number of burners (*a*).........	12	14	13	16
Heating surface (*b*) (*c*).........	373	378	379	397
Pounds of oil (*c*) (*d*).........	400	325	320	401
Pounds of oil (*e*).........	1.07	0.86	0.845	1.01

(*a*), per boiler; (*b*), square feet; (*c*), per burner; (*d*) per hour; (*e*), per square foot of heating surface per hour.

For "additional" oil firing the burners *B* are installed above the grate, and are so arranged as not to prevent the feeding of coal. In some cases they are placed between the fire doors, instead of above. As the space is usually limited, the construction of the burner and air register is often combined, and the regulation of air accomplished by means of flaps. The air register is at *A*, the supply of oil being regulated by the cock at *C*.

Under natural draft the *Segovia*, belonging to the Hamburg-American Line, which has engines of 2,200 horsepower and a heating surface of 7,560 square feet, consumes 32 tons of oil per day, as compared with 45 tons of coal for the same work before the oil burners were fitted. The saving in weight



BOILER ARRANGED FOR ADDITIONAL OIL FIRING.

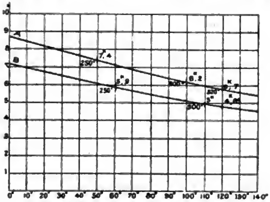
of fuel is seen to be about 30 percent. In the *Sithonia* and *Silvia*, of the same line, operated with Howden's heated air system, with 7,000 square feet of heating surface, the previous consumption of 42 tons of coal per day has been reduced to 27 tons of oil. This shows a saving of about 35 percent. A still greater saving is shown by the Austrian-Lloyd steamer *Almissa*, with 900 horsepower and 2,760 square feet of heating surface. The saving here is shown to be about 47 percent, so far as weight of fuel is concerned.

NOTE ON THE USE OF SUPERHEATED STEAM WITH MARINE ENGINES.*

BY FELIX F. T. GODARD.

Superheated steam was used in marine engines more than half a century ago, after Hirn's noteworthy experiments with the "Logelbach's" engine in Alsace. The French navy also tried it on some of their earliest protected cruisers. These early attempts were not, however, followed up, as it was found difficult to construct superheaters capable of maintaining a constant and sufficiently high temperature, and also because of the wear and tear of the hemp packings in use at that period.

The introduction of compound marine engines, more economical than the simple engines that had preceded them, caused the use of superheated steam to be given up for the



STEAM CONSUMPTION IN KILOGRAMS PER BRAKE HORSEPOWER, BASED ON SUPERHEAT, IN DEGREES CENTIGRADE.

time being. The same thing occurred with stationary engines, where improvements in valve gear enabled a high ratio of expansion to be employed, and the clearances to be reduced to a very small percentage of the cylinder volume.

In the Vosges and Alsace, however, the problem of using superheated steam in stationary engines was revived some fifteen years ago. Several different arrangements were designed by Mr. E. Schwoerer, a former assistant of Hirn, who used a massive superheater placed behind the fire bridge of the boiler furnace, and this gave such promising results that the study of the question of superheated steam was taken up by a number of manufacturers, chiefly in Germany, Alsace and Switzerland. It was found that engines fitted with Sulzer Colman valves, which were largely employed in those countries, were very suitable for use with superheated steam. In France, where the Corliss gear was usual in stationary engines, superheating did not make much progress, because it was not suited to the Corliss engine, or, in fact, to any flat slide-valve engine. The exhibits at the Paris Exhibition of 1900 showed this to be the case.

Since then, the use of superheated steam with stationary engines has increased largely, and considerable economy has been effected thereby. It is not unusual to find engines of 1,500 to 2,000 horsepower using steam at 300 degrees C. (572 degrees F.), and working at an expenditure of only 4 kilograms (9 pounds) of steam per indicated horsepower† per hour. There is but little information, however, on the subject of the variation in the consumption of steam in relation to its temperature.

A few years ago the author made some experiments on a triple expansion engine with piston valves, the temperature of the superheated steam varying from 0 to 120 degrees C. The results of these trials still present some features of interest. In the diagram (Fig. 1) the abscissæ represent the

* Read before the Institution of Naval Architects, April 9, 1908.

† Indicated horsepower referred to in this paper is the French "force de cheval" of 75 kilogram-meters per second = 0.986 British indicated horsepower.

amount of superheat, *i. e.*, the difference between the actual temperature of the steam (in degrees C.) and the temperature corresponding to the pressure when the steam is saturated. The ordinates represent the weight of steam consumed per effective brake horsepower.

This engine had cylinders 20, 33, 37 and 37 centimeters (7¾, 13, 14½ and 14½ inches) in diameter, with a stroke of 29 centimeters (11½ inches). At 440 revolutions per minute the brake horsepower was 300. The cut-off of 0.7 gave a ratio of expansion of 9.8. The pressure in main steam pipe (exhaust at atmosphere) was 12.8 kilograms (182 pounds) per square inch; at exhaust of condenser it was 15 kilograms (214 pounds) per square inch.

Now, curve *A* in the diagram (Fig. 1) (exhaust to atmosphere) shows that the consumption per hour of saturated steam (*i. e.*, with no superheat) is 8.85 kilograms (19½ pounds) per brake horsepower, whereas it falls to 5.7 kilograms (12¾ pounds) at a temperature of 320 degrees C. (608 degrees F.), equivalent to a superheat of 120 degrees C. (216 degrees F.).

The saving therefore amounts to

$$\frac{8.85 - 5.70}{8.85} = 35.5 \text{ percent.}$$

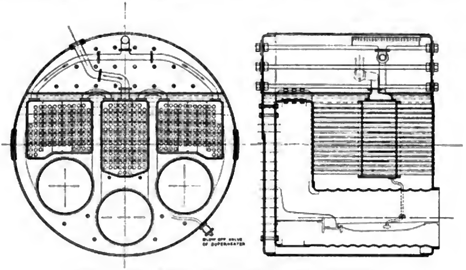
Taking curve *B* (exhaust to condenser), the consumption per brake horsepower falls from 7.15 kilograms (16 pounds) with no superheat to 4.85 kilograms (10½ pounds) with a superheat of 120 degrees C., or a saving of

$$\frac{7.15 - 4.85}{7.15} = 32 \text{ percent.}$$

It will be seen, therefore, that superheating may lead to an economy, as compared with saturated steam, of 35 percent in engines of this type exhausting to the atmosphere, and 32 percent for those exhausting to the condenser. The amount of reduction in steam consumption depends, of course, upon the design of the engine under consideration; in the present case it amounts to about 1 percent for every 4 degrees C. (7.2 degrees F.) of superheat. This is a figure frequently given, and which the author has been able to verify elsewhere.

Doubts, however, have often been expressed in regard to the efficiency of superheating in actual practice. These arise from the wear of the valve gear of the engines, which causes losses that neutralize part of the economy obtained by using superheated steam. It is now recognized by all the makers of land engines that, in order to use steam at a temperature of 280 degrees to 320 degrees C. (536 degrees to 608 degrees F.), the engine friction must be as small as possible, as, for instance, in reciprocating engines with lift valves, and still more so in turbine engines. Superheated steam is now generally adopted for land engines by reason of the economical results obtained in practice, which, in certain special cases, have effected a saving of upwards of 33 percent.

For marine engines the case is very different. England was the first country to take up the matter; in 1900, Messrs. Wilson & Sons, of Hull, installed superheaters on board the steamship *Claro*, which appear to have given satisfactory results. Other installations followed with varying measures of success. The Admiralty investigated the question on the battleship *Britannia*, with satisfactory results. Superheating has also been adopted in the United States on the steamship *Creole*, fitted with Curtis turbines, and in Germany on the *Ersatz Komet*, with Parsons turbines. Nevertheless, superheating in marine engines cannot be said to have gained ground as rapidly as was expected. It may, therefore, be of interest to record some very encouraging results which have been obtained in France within these last few years.



CYLINDRICAL BOILER OF STEAMSHIP PEROU, FITTED WITH PIELOCK SUPERHEATER.

In 1906 the Société de Saint-Nazaire built two identical cargo boats for the Compagnie Générale Transatlantique. They were the *Garonne*,‡ fitted with ordinary triple expansion engines and slide valves, and the *Rance*‡ with similar engines, but fitted with the Lentz valve gear. The boilers of the latter vessel are similar to those of the former, except that they are fitted with Pielock superheaters.

The leading dimensions of these two ships, their engines and boilers are as follows:

Length	91. meters (298 feet 6 inches)
Beam	12.2 meters (40 feet)
Molded depth	7.75 meters (25 feet 5 inches)
Load draft	6.4 meters (21 feet)
Gross tonnage	2,700 tons.
Diameter of cylinders	584, 914 and 1,498 millimeters.
Diameter of cylinders	23, 36 and 59 inches.
Stroke	1,066 millimeters (42 inches.)

The boiler installation of each ship consists of two cylindrical boilers, each having two furnaces and fitted with Howden's forced draft. In each case the grate area is 8.4 square meters (90.42 square feet), and the total heating surface 350.08 square meters (3,767 square feet). In the case of the *Garonne* this was all ordinary heating surface. In *La Rance*, however, 73

‡ International Marine Engineering, page 371, September, 1907.

square meters (785 square feet) of the amount was superheating surface.

The trials of these two vessels were carried out under conditions as similar as possible, so that the comparison of results might be quite fair, and the coal used was the same in both cases. The results of the trials were as follows:

	Garonne.	*Rance.*
Date of trials	July 6, 1906.	September 13, 1906.
Boiler pressure	12.60 kg. (178 lbs.)	12.54 kg. (177 lbs.)
Steam temperature	192°C. (377.6° *Fahr.*)	270° C. (518° *Fahr.*)
Revolutions	72.3	75.37
I. H. P.	1,104	1,304
Coal consumption—per I. H. P.	511 grams (1.12 lbs.)	408 grams (0.9 lb.)
Advantage of superheating:		
Increase of power		18.1 percent.
Reduction of coal consumption		20.1 percent.

Both ships were put into service directly after the trials. It is now over a year since these two cargo boats have been engaged upon an exactly similar service, and it has been possible, therefore, to obtain accurate data regarding their working and comparative coal consumption. Taking for each ship ten trips made at corresponding dates, so as to have as far as possible identical conditions of weather, loading and quality of coal used, the fuel consumption per mile worked out at 69.981 kilograms (154 pounds) for the *Garonne* without superheating; 57.228 kilograms (126 pounds) for the *Rance* with superheating.

Comparing these figures, we have an economy in coal consumption in favor of the *Rance* of

$$\frac{69.981 - 57.228}{69.981} = 18.2 \text{ percent.}$$

There was, moreover, no trouble with either engines or boilers. No leakage has occurred in the valves, which continue to bear simultaneously on both upper and lower seatings. The superheater has not required any particular attention; a constant steam temperature has been maintained, which rises only a few degrees when additional power is required of the boilers, and falls again automatically directly the engines are stopped.

In consequence of the results of the early trials of the *Rance*, the Compagnie Générale Transatlantique installed Pielock superheaters and Lentz valve gears on the steamship *Pérou*,§ for service to the Antilles (West Indies), and also on the intermediate cargo boat *Caroline*. The same arrangement is being adopted on the cargo boat *Honduras*, and other cases are under consideration. Each of these vessels is to be comparable to a sister ship, working with saturated steam, in order to follow up on a larger scale the conclusive results already obtained with the *Rance* and the *Garonne*.

The *Pérou* has just completed her trials. She is identical, save for the superheating and valve gear, with the steamship *Guadeloupe*§ employed on the same service, and which was completed in September, 1907.

The dimensions of these two ships are as follows:

Length	131. meters (429 feet 9 inches)
Beam	15.86 meters (52 feet)
Molded depth	10.5 meters (34 feet 6 inches)
Load draft	6.6 meters (21 feet 7 inches)
Gross tonnage	6,800 tons.

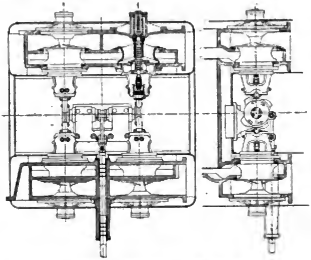
The illustrations give the details of the valve gear and a section of the boiler and superheater.

Each vessel is fitted with twin-screw triple expansion three-cylinder engines of the following dimensions:

§ INTERNATIONAL MARINE ENGINEERING, page 373, September, 1907, and page 44, January, 1908.

	Guadeloupe.	*Pérou.*
Diam. of cylinder (H.P.)	0.685 m. (27 in.)	0.685 m. (27 in.)
Diam. of cylinder (M.P.)	1.092 m. (43 in.)	1.060 m. (41¾ in.)
Diam. of cylinder (L.P.)	1.828 m. (72 in.)	1.828 m. (72 in.)
Stroke	1.219 m. (48 in.)	1.219 m. (48 in.)

The boiler installation of each ship comprises six cylindrical boilers having three furnaces each, and fitted with Howden's forced draft. The working pressure is 13 kilograms (185 pounds) per square inch. In each case the grate area is 32.13 square meters (346 square feet). The *Guadeloupe* has ordinary heating surface of 1,255 square meters (13,509 square feet); while the *Pérou* has 932.7 square meters (10,030 square feet) of ordinary heating surface and 302 square meters (3,260 square feet) of superheating surface; a total of 1,234.7 square meters (13,290 square feet).



VALVE GEAR OF LOW-PRESSURE CYLINDER ON PEROU.

The speed trials of both vessels, which were carried out under absolutely similar weather conditions, gave the following results:

	Guadeloupe.	*Pérou.*
Date of trials	September 9, 1907.	February 6, 1908.
Boiler pressure	13 kgms. (185 lbs.)	13 kgms. (185 lbs.)
Temperature of steam at engines	192° C. (377.6° *Fahr.*)	238° C. (460° *Fahr.*)
Revolutions	88.19	88.47
I. H. P.	6,585	6,750
Speed	16.60 knots.	16.95 knots.

These results were considered most satisfactory, both by the Postal Commission and by the owners of the vessels.

A noteworthy feature is the constant temperature of the superheated steam. This temperature was taken at admission of steam to the engines by means of a Fournier recording thermometer. The diagrams obtained representing the temperatures of the steam, both during firing of the boilers before the trials, during the trials, and also while slowing down, and those taken during the first voyage in service show that the variations of temperature are very small, and do not exceed 20 degrees C. (36 degrees F.) from the time of starting the engines to that of running at full power, which includes also the period of cleaning the fires.

These results are very interesting, as being applicable also to the use of superheated steam in large turbines on board ship. The absence of sudden changes of steam temperature in turbine engines will prevent the apparatus from being exposed to sudden expansion and contraction, the effects of which might be serious.

Published Monthly at

17 Battery Place New York

By MARINE ENGINEERING, INCORPORATED

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President

E. L. SUMNER, Secretary

and at

Christopher St., Finsbury Square, London, E. C.

E. J. P. BENN, Director and Publisher

SIDNEY GRAVES KOON, Editor

Branch Offices { Philadelphia, Machinery Dept., The Bourse, S. W. ANNESS. Boston, 170 Summer St., S. I. CARPENTER.

The edition of this issue comprises 6,000 copies. We have no free list and accept no return copies.

Naval Disasters.

The month of April of 1908 has been unusually prolific in disasters of a serious nature affecting warships. Strange as it may seem, the four most prominent cases of this sort have all fallen upon the shoulders of the Anglo-Japanese allies. Britain has lost three warships by collision, each vessel being practically cut in two by the colliding ship, while Japan has just lost an old cruiser by an explosion, and more than two hundred of her crew went down with her.

To recapitulate these losses, it is sufficient to state that early in the month the destroyer *Tiger* (383 tons and 30 knots; launched in 1900) was cut completely in two by the armored cruiser *Berwick* (9,800 tons and 23 knots; launched in 1902), and thirty-six lives were lost from the destroyer's crew. The accident occurred at night, during maneuvers.

A few weeks later the American Line steamship *St. Paul* crashed into the cruiser *Gladiator* (5,750 tons and 20 knots; launched in 1896) and damaged her so severely that she sank in 20 minutes, with a loss of twenty-eight men. Scarcely had the echoes of this disaster disappeared than another followed on its heels, when the destroyer *Gala* (570 tons and 26 knots; launched in 1904) was cut in two by the scout *Attentive* (2,670 tons and 26 knots; launched in 1904) and sent to the bottom. In this case only one life was lost.

The Japanese accident occurred early in the morning on the last day of the month, while the ship was at anchor in harbor. An explosion of a magazine in the cruiser *Matsushima* (4,277 tons and 16 knots; launched in 1890) sent the vessel promptly to the bottom with a loss of 207 men, many of whom were cadets, engaged in a practice cruise on this vessel, which was attached to the training squadron. This ship is interesting as having been, in 1894, at the battle of the Yalu, the flagship of Admiral Ito, and as having been instrumental in that memorable fight in the capture of a Chinese armored battleship, although none of the vessels in the Japanese squadron was armored.

All of these accidents may be classed under the general heading of unavoidable. Two of them occurred during maneuvers at night, and may be set down to the natural risks run in operating ships of war during maneuvers, and at all other times; one of them occurred during a heavy fog accompanied by a severe snow storm, and a court of inquiry has exonerated from blame the officers of both vessels; the other occurred by an unforeseeable explosion, such as that which over two years ago destroyed Togo's famous flagship, the *Mikasa*, while the vessel was lying peacefully at anchor in a home harbor. It may also be compared with the disaster which overtook the French battleship *Iéna* a little more than a year ago, while the ship was in dry-dock in the dockyard at Toulon. The *Mikasa* has recently been repaired; the *Iéna* was so seriously damaged as to be a total loss; and it is probable that the *Matsushima*, particularly in view of her age, will not be salved.

Large Steam Yachts.

In our present issue will be found descriptions of three of the largest privately-owned steam yachts afloat, all built during the past year for American owners by British yards. Each of these vessels is a splendid example of naval architecture, and is a decidedly notable addition to the rapidly increasing fleet of steam yachts of the world.

Perhaps the most significant feature of the whole thing is that, although these yachts are built for Americans, they were constructed all in Scotch yards, and two of them were of Scotch design.* The whole proposition appears to have been one where low cost of

* To this list might be added a fourth large steam yacht—the *Cassandra*—launched from a Clyde yard in February, for an American yachtsman, and building from American designs.

production was an important feature, notwithstanding the necessarily great wealth of the individual owners, and, of course, it goes without saying that, so far as cost is concerned, the Scotch yards can compete with any in the world.

Numerous statements have been made from time to time regarding the financial relations between marine construction in the United States and that in Great Britain and on the continent. When it comes to a question of quality there is perhaps little to choose; but the all-governing commercial item of cost militates so strongly against the American yards, as compared with their competitors, as to make it practically out of the question for these yards to obtain any business except that under the protection of the coasting trade laws, which require vessels engaged in that service to be built in American yards.

While it would be idle for us to enter here into a discussion of relative wage scales, yet figures put into our possession two or three years ago, comparing wages in British yards with one of the American yards, are significant. In the case of the British yards the figures show the average of twelve representative plants. There are thirty classes of employees compared in each case, ranging from draftsmen through the pattern, blacksmith, machine, boiler and joiner shop to ship carpenters, fitters, riveters and coppersmiths, with apprentices, helpers and boys under most of the several headings. In only eleven of the thirty cases cited does the American wage fall below *double* the British wage; in only five cases of these eleven is the excess less than 90 percent; in no case is this excess less than 70 percent. Comment is superfluous.

A single example of this sort suffices to show good and sufficient reason why the American merchant marine in the foreign trade, and the American shipyards in general, are in a very precarious position. With a wage scale approximately double that of their competitors: with material costing no less, and in some cases markedly more; with social aspirations and family ties operating in some cases to disparage business ability and technical training, for which they are ostentatiously substituted; with many glaring examples of financial juggling in connection with organization and reorganization *ad infinitum;* it is no wonder that prosperity does not rest upon them. Until some measures are provided amelioriating these conditions, or in some way equalizing the differences existing in comparison with British and continental yards, it were idle to hope for any marked improvement.

Steering Gear.

Our notes in another column, covering steam steering gear, have been prepared for us by four or five different manufacturers in Britain and America. The first successful steam device for the steering of ships appears to have been inaugurated only forty-two years ago. Prior to that time reliance was placed almost entirely upon hand steering, and the burly arms of sometimes as many as four quartermasters were required in heavy weather to keep a ship on her course. With the advent of mechanical means for performing this, one of the most important functions on a large ship, it has become possible to handle the vessel from whatever point of vantage may be most convenient, and the muscular effort required is practically negligible.

A powerful combination of gears fitted for this purpose, and including in most cases worm gears of slow speed and great strength, have made it possible to concentrate in a small space the agency for handling the rudder. As a general proposition, in merchant ships this is placed far above the waterline, many of the largest liners having the gear located in a small deckhouse directly over the rudder head. In most warships, however, and in certain special merchant vessels, such as the *Lusitania* and *Mauretania,* the entire gear is located well below the waterline, and usually below an armored deck as well. Here it is entirely protected from a chance or a deliberate shot, and may be relied upon to do its work silently and efficiently, in accordance with the requirements of the man on the bridge.

Accidents to rudders and steering gear, due largely to the shocks occasioned by impacts upon the rudder of heavy seas, are not infrequent; and as the blows are both sudden and severe, heavy construction is necessary to insure immunity from disablement on this score. With a twin-screw ship the loss of a rudder, or of proper means for controlling it, while sufficiently serious, may yet, by skillful seamanship, be largely neutralized, as was the case with the *Kaiser Wilhelm der Grosse* last fall. Sailing vessels, by a careful setting and manipulation of the sails, may in many cases be said to be largely independent of rudders, except for working in narrow waters. They may, moreover, being usually relatively small, be readily fitted with "jury" rudders, or some other makeshift device, which answers the purpose of bringing them safely to port.

With single-screw steamers, however, in which by far the largest part of the world's seaborne traffic is carried on, the problem is one of great moment, and anything which deranges the steering mechanism endangers the very safety of the vessel. The bulk of the ship is usually too great to be largely influenced by anything of the nature of a "jury" rudder, and reliance must be had upon meeting another vessel, and being towed into port—large salvage claims being a natural outcome of the situation. The familiar "ounce of prevention" adage is thus seen to be strictly applicable here.

The great importance of the subject is thus apparent, and some of the inherent weaknesses of steering gears are pointed out in our article, in which most of the general types of gear are covered.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

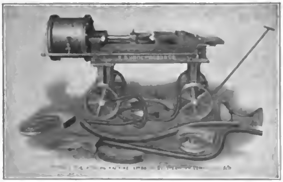
	Tons.	Knots.		Mar. 1.	April 1.
			BATTLESHIPS.		
South Carolina	16,000	18½	Wm. Cramp & Sons....	39.5	42.2
Michigan....	16,000	18½	New York Shipbuilding Co....	45.0	48.6
Delaware..	20,000	21	Newport News S. B. & D. D. Co	12.77	18.1
North Dakota...	20,000	21	Fore River Shipbuilding Co...	21.4	25.7
			ARMORED CRUISERS.		
North Carolina..	14,500	22	Newport News Co........	98	99
Montana.....	14,500	22	Newport News Co...	94.96	97.
			SCOUT CRUISERS.		
Chester.....	3,750	24	Bath Iron Works	98.38	99.1
Birmingham...	3,750	24	Fore River Shipbuilding Co.	96.69	99.1
Salem......	3,750	24	Fore River Shipbuilding Co..	94.31	95.2
			TORPEDO BOAT DESTROYERS.		
Number 17	700	28	Wm. Cramp & Sons.......	6.88	12
Number 18	700	28	Wm. Cramp & Sons......	6.8	10.8
Number 19	700	28	New York Shipbuilding Co....	8.4	11.5
Number 20	700	28	Bath Iron Works.........	5.38	8
Number 21 ..	700	28	Bath Iron Works	4.91	7.8
			SUBMARINE TORPEDO BOATS.		
Cuttlefish ..	—	—	Fore River Shipbuilding Co..	99	99
Number 13...	—	—	Fore River Shipbuilding Co..	23	30
Number 14.	—	—	Fore River Shipbuilding Co.	23	30
Number 15	—	—	Fore River Shipbuilding Co..	23	30.1
Number 16	—	—	Fore River Shipbuilding Co.	16.3	29.9
Number 17....	—	—	Fore River Shipbuilding Co	7.5	10.3
Number 18 ...	—	—	Fore River Shipbuilding Co..	7.5	10.3
Number 19	—	—	Fore River Shipbuilding Co	7.5	10.3

ENGINEERING SPECIALTIES.

A Portable Pipe-Bending Machine.

This can be driven by steam or compressed air, at 80 to 100 pounds pressure, and will bend iron pipe, cold, up to 2 inches in diameter without filling, flattening or splitting the pipe. It is also claimed that right-angle bends can be made in 2-inch pipe in two minutes or less, thus efficiently doing the work almost as rapidly as the pipe can be fed to the dies.

The piston is forced back on the return stroke by a spiral spring, projecting into a round boss of the cylinder head; the front head and piston rod requiring no packing. The end of the piston rod is supported in a crosshead, which slides in the guides. Six dies are furnished, and include sizes from ½ inch to 2 inches. The dies are easily and quickly changed, the



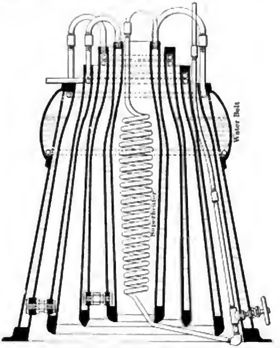
female die being centered by a dowel in the angle plate, which is adjustable along the bed-plate, bolted in place, centered and supported against the thrust of the air piston by large dowel pins. The male die is centered and supported on the end of the piston rod, which projects through the crosshead.

The truck shown in the illustration is an extra addition, and it is one which has proved so useful as to be almost an essential convenience.

This machine was designed especially by H. B. Underwood & Company, 1025 Hamilton Street, Philadelphia, Pa., for general use wherever it becomes necessary to bend pipe.

A Tubeless Boiler.

The odd device illustrated has been developed by G. R. Steward, 28 Victoria street, Westminster. The boiler consists of a series of cones with annular water spaces between and combustion chambers between the water spaces. The section which we show indicates that the two sides of each combustion chamber are thoroughly exposed to the heated gases, so that, with the exception of the outer shell, the entire boiler surfaces may be considered as heating surface. In each of the conical annular spaces the thickest body of water is at the bottom, where the greatest heat is attainable from the fire. The various sides of cones are connected together by hollow stays, acting as passages for steam and water.



Evaporation is very rapid, and in the interests of keeping the water at a constant level, a water belt, outside the main cone of the boiler, is fitted, with direct communication to the outer cone of the boiler for water and for steam. A perforated pipe around the bottom of this reservoir is supplied with live steam for raising the temperature of the water in this section nearly to the boiling point before it enters the boiler. The cones vary in height, partly to give freedom to the gases at the bottom, and partly to give increasing steam space to the inner water chamber before the steam enters the superheater. The latter is composed of a coil of tubing, so arranged that it may be flooded when the fire is first lighted, to prevent burning out. Around the tops of several of the water columns are fitted perforated coils, through which water is passed, and this is flashed into steam on striking the inner sides of the water columns.

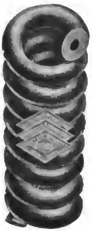
From cold water steam was raised, without the use of the flash, in 2 minutes 3 seconds, and a pressure of 150 pounds was reached in 5 minutes 55 seconds from the start. Starting with hot water this same pressure was reached in 2 minutes 55 seconds.

A 10-horsepower boiler of this type, tested in March of this year, had a boiler-heating surface of 30 square feet, a superheater surface of 1 square foot, and a grate area of 1.4 square feet. The ratio of heating to grate area was 21.5 to 1. At a mean boiler pressure of 140 pounds there was evaporated during a four-hour test 608 pounds of water (4.4 boiler horsepower) from and at 212 degrees F., on a consumption of 43 pounds of paraffin (kerosene). This shows an evaporation of

14.1 pounds of water, standard, per pound of fuel. In this case the temperature of the superheated steam was 615 degrees F. Coal and coke have also been used as fuel in this boiler.

A High-Pressure Spiral Piston Packing.

Cobb's piston and valve rod packing, manufactured by the New York Belting & Packing Company, Ltd., 91 Chambers street, New York, is designed especially for withstanding heat



and the highest pressure. The rubber core of the packing is oil and heat proof, acting as a spring or cushion in holding the packing up to the rod. The outer covering is made of material not affected by heat. The lubricants employed are said to be entirely free from grits and acids.

This packing is said not to get hard under any degree of heat, and is furnished either round or square, and either spiral or in straight lengths. When it is first put in, the glands are screwed up with a wrench, to give the packing the proper shape, then two or three turns are put in to compress the packing, the glands are then released again, and finally screwed up by hand until the packing is fully expanded.

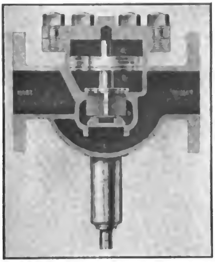
The Collin Steam-Pressure Regulating Valve.

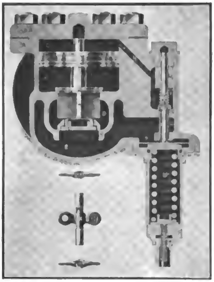
The illustrations are sectional views, at right angles to each other, of this device, type B, made by the Ohio Brass Company, Mansfield, Ohio. Two features to which attention is called are the absence of springs for opening and closing the main valve, and the absence of dash-pots for cushioning; the valve cushions inherently when closing, and is balanced when open, its operation depending upon the pressure of the fluid passing through it. The steam enters the valve chamber *B* in such a way as to distribute its force evenly against the valve. It enters the chamber *C* through a small hole drilled in the main piston *K*.

The spring case *T* carries the regulating spring *U*, which forces the diaphragm *S* upward against the pressure of the outlet side of the valve. The controlling valve chamber *F* connects with the main valve chamber *C* through the regulating port *H*. This chamber contains the controlling valve *G*, which is held to its seat by the pressure and by the spring *P*. At the lower end, the controlling valve is also in contact with the diaphragm.

As soon as the pressure in the outlet or service side begins to drop, the spring *U* forces the controlling valve from its seat, allowing the steam in the chamber *C* to pass through the regulating port to the controlling valve chamber and the outlet *E*. The pressure in the chamber *C* is therefore reduced below that in *B*; the main valve rises and permits steam to pass to the service side. When the pressure on that side has been restored, the diaphragm forces back the regulating spring and allows the controlling valve to seat. As soon as this occurs, the pressure in the chamber *C* builds up, and the main valve *J* starts to close.

Below the main valve, guide wings *M* extend through the

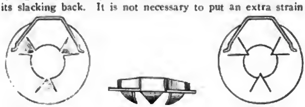




cushioning chamber *D*, and carry a supplementary piston *L*, which enters the port *N* when the valve is closed. When the main valve opens, it lifts beyond a point where steam cutting can occur before the supplementary piston opens its port. This is to prevent the cutting of the main valve and seat. In closing, the supplementary piston enters the port *N*, checking the flow of steam and allowing the main valve to come to its seat against a steam cushion, formed by high-pressure steam in the chamber *D*.

The Fastnut Washer.

This device is placed on the market by Fastnut, Ltd., 60 Aldermanbury, London, E. C., and is particularly designed to hold nuts and screws tight, no matter what the vibration. It has been supplied to the British Admiralty and to many steamships. It is dropped over the bolt, teeth downwards, in place of the ordinary washer, and the action of screwing up the nut flattens the teeth and holds the washer tight to the bolt. The spring flanges on top allow the nut to be turned, but prevent its slacking back. It is not necessary to put an extra strain



BEFORE USE SIDE SECTION IN USE

on the thread of the nut by screwing up unduly tight, and no cotter pins are required. It goes without saying, however, that the head of the bolt must be thoroughly in place before the "Fastnut" is applied. This washer may be removed, after the nut is unscrewed, by being pried up sufficiently to release the teeth, when it may be unscrewed from the threads without damage to the bolt.

The regular sizes in stock are fourteen in number, varying from 3/16 inch to 1½ inches in diameter of bolt or screw. They are made of brass, and are fitted for either hexagonal or square nuts.

TECHNICAL PUBLICATIONS.

Neuere Schiffsmaschinen. By H. Rosenthal. Size, 7 by 9¼ inches. Pages, 378; figures, 29. Berlin, 1908: Konrad W. Mecklenburg. Price, 10 marks (price of plates, 20 marks; complete work, 30 marks).

In February of 1907 we mentioned the book of plates, 53 in number, measuring 10¾ by 15½ inches, and including a total of more than 1,200 drawings of the various parts of the machinery used on board warships and merchant vessels. The present text covers the same ground as these plates, being explanatory, not only of the drawings in themselves, but also of the methods of obtaining results as exemplified in the finished work. The book is divided into six parts and an appendix, covering, respectively, ships' boilers, the main engines, auxiliary engines and apparatus, steam engines and motors for small vessels, steam turbines and ship construction, the latter item being very brief. The entire work is descriptive, there being practically nothing of a theoretical nature involved, and such illustrations as are used in the text are simply small sketches to supplement the more important illustrative material in the book of plates.

The work is well printed, and may, we presume, be fully relied upon for the ground which it covers.

Practical Shipbuilding: a Treatise on the Structural Design and Building of Modern Steel Vessels. By A. C. Holms. Text, 5¾ by 9⅜ inches. Pages, 638. Plates, 15¾ by 12½ inches, 115 in number. London and New York, 1908: Longmans, Green & Company. Price, 30s. net and $10.00 net.

This is the second edition, in two volumes, of a work which first appeared about four years ago. The text has been revised and some new matter added. During the four intervening years, however, neither the structural design of steam vessels nor shipbuilding practice has undergone any marked alteration. In a number of minor details, processes and appliances there has been alteration, and it is to take care of these items that the revision has been made. Two new plates are added to the volume of illustrations (there are no illustrations whatever in the text), and the work is believed to be now entirely up to date.

The text is divided into two parts, of which the first deals with the design and arrangement of the various items entering into the structure of the ship, and covers about 450 pages. The second part deals with the operation of the drawing office and mold loft, and with the work as performed in the shipyard of bending the frames, making and using templates and the various parts of the general work of handling and working the materials and building a ship. An appendix, dealing with elementary considerations on the strength and stiffness of beams, is followed by an unusually complete index, covering some 30 pages.

Throughout the work the rules of *Lloyd's Registry* are frequently mentioned, and are taken in general as the standard of constructive practice, though occasionally variations are introduced to conform to the practice of the British Corporation and the Bureau Veritas. Theoretical discussion, involving higher mathematics and mechanics, has been avoided, although, of course, the results of such investigations are freely made use of as established facts. This renders the work much more valuable to the general reader, though detracting somewhat from its value to the special investigator; in the interests of limiting the size of volume, however, this method has been considered preferable to using a large amount of material which the ordinary reader would not need. To assist the investigator numerous foot notes refer him to the original sources of the information presented, so that the theoretical features of the various problems involved may be followed out in this manner.

Throughout the work boldfaced catch heads have been used to call attention to the main items in the several paragraphs, and free use is made of references back and forth between the text and the plates. The latter, while entirely of the zinc pattern (except for a few half-tones illustrating shipyard tools) are very clear and well reproduced. They include details of every part of the ship's structure, as well as general drawings, showing the arrangement of the principal compartments on ships of various types, the expansion of shell plating, the development of water lines and buttocks, and even such details as masts and rigging in steam and sailing vessels. The amount of information included is enormous, and the book is an exceedingly valuable portion of our literature on this subject.

Profit Making in Shop and Factory Management. By Charles U. Carpenter. Size, 5¾ by 8½ inches. Pages, 146. New York and London, 1908: *The Engineering Magazine*. Price, $2 (8s. 6d.)

This work is a concise expression of the methods which the author has developed in connection with the National Cash Register Company and the Herring-Hall-Marvin Safe Company, of which latter he is president. The contents appeared first in the form of a series of articles in *The Engineering Magazine* during 1907. They have been carefully revised, somewhat enlarged and rearranged, and now divided into chapters. The work was produced in the midst of the author's labors in the management of a great manufacturing company, and was inspired by his keen interest in the promotion of better ideals in industrial organization.

It is divided into fourteen chapters, covering, respectively, the reorganization of run-down concerns; the practical working of the committee system; the necessity for reports and their uses; the designing and drafting department; the tool room; minimizing the time of machine tool operations; the use of high-speed steel; the determination of standard times for machine operations; standard times for handling the work; standard times for assembling; stimulating production by the wage system; stock and cost estimates; the upbuilding of a selling organization, and effective organization in the executive department.

The work takes up the defects in the various departments and methods of overcoming difficulties of this character; and is illustrated simply by tables or forms for cards for recording work in its various processes through the shop. Stress is laid upon the importance of putting the work in control of competent men, no matter what salary may be demanded. It is shown to be more expensive, in the long run, to employ an incompetent man at a low salary than a thoroughly competent man at several times this figure. The whole keynote seems to be the obtaining of the best efficiency from every unit in the works, whether that unit be human or a machine built of iron and steel.

SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

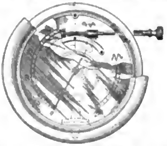
American patents compiled by Delbert H. Decker. Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

880,018. APPARATUS FOR RELEASING SHIPS' BOATS. JOSEPH FORCIER, SEATTLE, WASH.

Claim.—An apparatus for launching boats comprising means for lowering and holding a boat suspended in a lowered position, bases secured in opposite end portions of the boat, catch members pivoted to said bases for engaging said means, spaced uprights fixed to said bases, shafts supported for rotation in said uprights, keepers fixed to said shafts for holding said catch members against swinging, said keepers projecting from the outer ends of said shafts, a shaft rotatably supported beneath said first named shafts and provided with an operating handle, arms fixed to the other ends of said first named shafts, arms fixed to the last named shaft, and links connecting the arms of said shafts. One claim.

878,034.—STEAM OR VACUUM GAGE. JAMES ELY, 85 CHAMBERS STREET, NEW YORK.

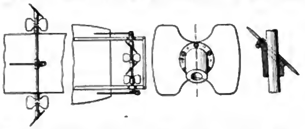
Claim.—In a steam gage, the combination with a casing, a rotatable indicating hand and means for rotating same in the operation of the device, of a rotatably mounted scale carrying disk, means arranged



within the casing for rotatively adjusting same and for locking the disk in its adjusted position, and a removable key by which access may be had to such adjusting means from the exterior of the casing. Three claims.

880,353. PADDLE WHEEL. OTTO BROWN, SACRAMENTO, CAL.

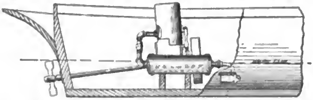
Claim 2.—In a propelling device for vessels, the combination of propelling blades arranged in pairs, each pair composed of two sets of blades



disposed on opposite sides of a common shaft in alternate manner, and with the blades of the same at an oblique angle and in contrary position to the blades of the other set, said blades being adjustable at varying angles with respect to the axis of rotation. Two claims.

880,604. EXHAUST MECHANISM FOR EXPLOSIVE ENGINES. J. M. AND E. E. TRUSCOTT, ASSIGNORS TO TRUSCOTT BOAT MANUFACTURING COMPANY, ST. JOSEPH, MICH., A CORPORATION.

Claim 3.—In combination with a boat having an explosive motor mounted thereon, exhaust mechanism for the motor, comprising an expansion tank having communication with the exhaust pipe of the motor,

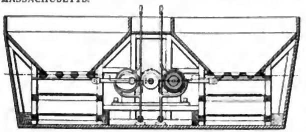


a part of said tank being located below the waterline, and an outlet pipe leading from the tank and extending through the bottom of the boat below the waterline thereof, the discharge end of said outlet pipe being free and unobstructed, and directed toward the stern of the boat. Eleven claims.

880,895. BOAT-DETACHER. ERIK H. LINDMAN, SAN PEDRO, CAL.

Abstract.—The invention relates to means for securing and releasing boats, and has for an object to provide means whereby the boat may be automatically released by the action of the water in case of a vessel sinking; or by which the boat may be quickly released by hand whenever desired. Six claims.

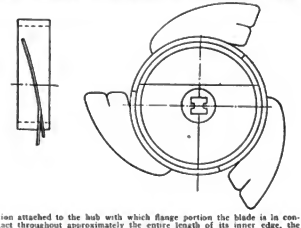
881,446.—APPARATUS FOR UNLOADING VESSELS. AARON SCHWARTZ, BOSTON, MASS., ASSIGNOR TO AUTOMATIC RAPID UNLOADING COMPANY, BOSTON, A CORPORATION OF MASSACHUSETTS.



Claim 3.—In a movable carrier for sand, coal, and similar material, the combination, with a belt conveyer, of a hopper located with its discharge outlet above said conveyer, two slotted plates at said discharge outlet, one fixed and the other slidable, the walls of the slots therein being so inclined that the material will be cut through by the reciprocation of said slidable plate to effect a delivery; and means for reciprocating said slide. Ten claims.

881,393.—SHIP PROPELLER. CARL J. H. FLINDT, COPENHAGEN, DENMARK.

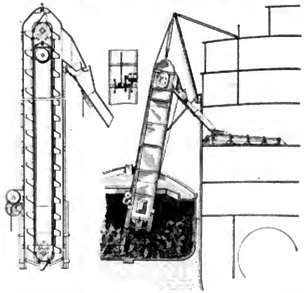
Claim.—A propeller, comprising a shaft, a hub thereon, and wing-shaped propeller blades, each provided with an arc-shaped flange por-



tion attached to the hub with which flange portion the blade is in contact throughout approximately the entire length of its inner edge, the broad ends of the blades being split in the direction of their movement, and the portion between the split and the hub having an angle to the axis of the shaft comparatively smaller than the angle of the outer portion. One claim.

881,429.—APPARATUS FOR COALING VESSELS. LOUIS A. DE MAYO, OF NEW YORK, ASSIGNOR TO DE MAYO COALING COMPANY, NEW YORK, A CORPORATION OF NEW JERSEY.

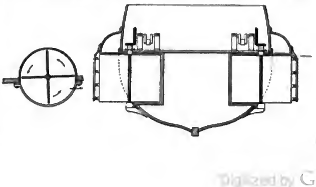
Claim 1.—In an apparatus for coaling vessels, the combination of an



elevator, a boom adapted to be secured to a vessel, a tackle adapted to be secured to the boom and to the top of the elevator, and a winding mechanism mounted on the elevator and connected with the fall of the tackle. Nineteen claims.

881,537. MEANS FOR PROPELLING SHIPS. WILLIAM BETHANY, MARS, ARKANSAS.

Claim 1.—In propelling means for a ship, a casing of semi-circular form within each side of the ship, forming a chamber having an extended top about at the waterline, and its open side in the plane of the outer wall, the flooring of the vessel and the top of the casing forming

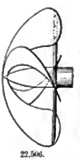


a double wall, a chambered hood secured to the ship's side and connected to the outer edge of the extended top of said casing and forming a watertight chamber overhanging the open side of the casing, and a propeller suspended by the flooring and supported in a bearing at the outer wall of the ship, and means for rotating said propeller. Two claims.

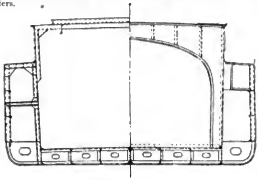
British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

22,506. SCREW PROPELLERS, FANS, ETC. W. BEEDLE, ROATH, CARDIFF.

In screw propellers having blades that meet at the geometrical axis of the boss, and are supported by arms connected to the boss, the blades are respectively united one to the other across the axis of the propeller, so that their edges are continuous. The surface of the blades is reduced in width towards the center, where they are supported within notches formed in the end of the boss. The invention is stated to be applicable to propellers for aerial or marine propulsion, as well as to fans and exhausters.



22,506.



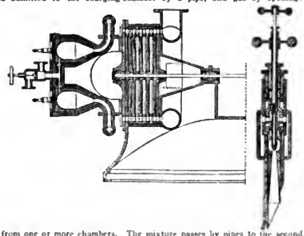
23,680.

23,680.—SHIPS. G. B. HUNTER, WALLSEND-ON-TYNE.

Sectional ships are constructed with detachable buoyant side portions extending to the bottom of the hull, to adapt them for passage through locks and canals of smaller dimensions than the ships. The width of the main portions of the hull is determined by the available width of the canals and locks, the sides are sloped to correspond with the lock walls, and the bottom is made double and utilized for water ballast. The side portions are adapted to form water-ballast tanks, and also to be detached when it is desired to float the vessel in sections through the lock. The main parts of the ship are temporarily secured by bolts, rivets, etc., the various parts being separated when required by careening.

23,074. ELASTIC-FLUID TURBINES. C. WEDEKIND, ST. JEAN SUR MER, FRANCE.

The arrangement described comprises charging apparatus, explosion chambers, and nozzles adapted to deliver the products of combustion of any combustible gas to the blade passages of a parallel-flow turbine. Air is admitted to the charging-chamber by a pipe, and gas by openings



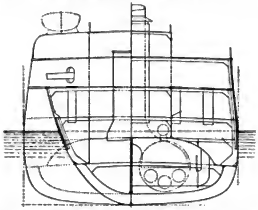
from one or more chambers. The mixture passes by pipes to the second combustion chambers, which are constructed of refractory material and are of any suitable shape. The securing plates and sparking plugs of such chambers are grouped round the charging apparatus. Cooling water may be circulated in the casing chamber, and may produce steam. A hollow needle, operated by a hand wheel, regulates the opening, and the small nozzle at the tip of the needle is itself regulated by another needle worked by a wheel. Steam from the water jacket enters and assists the gas in the nozzles.

23,123. ELASTIC-FLUID TURBINES. P. GHELLI, AVELLINO, AND C. G. CAZZANI, SAVONA, ITALY.

In a gas turbine, atmospheric air is caused to pass through the following cycle: (1) isothermal compression; (2) heating at constant pressure in a regenerator; (3) isothermal expansion in a turbine; and (4) cooling at constant pressure in the regenerator. The heat energy of the combustible gases, corresponding to the work done by the engine, is added during the third stage of the cycle. The turbo-compressor, arranged end on to the driving turbine to balance end pressure, is provided with a perforated casing and annular chambers from which water is delivered as spray. In this way, heat of compression is absorbed. The compressed air passes through the pipes of the regenerator and then an automatic regulating valve to the turbine. The combustible gases are introduced from the annular chambers through openings in the casing, and the temperature is sufficiently high for ignition to be spontaneous. The exhausting mixture of air and combustion products at a high temperature passes by a pipe to the regenerator, and there parts with its heat to the incoming air. The form of the regenerator and the method of transferring heat may be varied. Liquid or gaseous combustible is drawn from a reservoir and compressed by a pump, and is forced through pipes in the interior of the regenerator, where it is vaporized if necessary, and heated.

23,831. SHIPS' BULKHEADS; COMPARTMENTS. J. J. F. ANDREWS, OLD CHARLTON, LONDON.

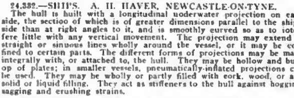
Two watertight decks extend right across the ship, one being above, and the other below, the waterline. The lower deck is curved or carried down to the sides of the vessel to meet the lower deck stringer. In addition, longitudinal watertight bulkheads are fitted, partial bulk-



heads being worked between the watertight decks. The spaces at the sides may be utilized as coal bunkers. The construction may be applied to battleships and cruisers, and to mail and passenger vessels.

22,689. SHIPS' HULLS. A. HUBER, WEIDENBACH, COLOGNE, GERMANY.

In a ship with a flat bottom, having a rearwardly-ascending flattened portion of uniform breadth starting at a suitable distance from the



stern frame, the sloped part, which is straight, curved, or of any other suitable section longitudinally, is flattened in cross section, and extends to the full width of the ship. The water, as it passes from beneath the ship, fills the space forward of the propeller and tends to help the ship forward by its pressure on the sloping surface. To prevent water from streaming laterally into the gap, the sides of the ship are extended downward to form side walls, upon which propellers may be carried.

24,332.—SHIPS. A. H. HAVER, NEWCASTLE-ON-TYNE.

The hull is built with a longitudinal underwater projection on each side, the section of which is of greater dimensions parallel to the ship's side than at right angles to it, and is smoothly curved so as to interfere little with any vertical movement. The projection may extend in straight or sinuous lines wholly around the vessel, or it may be confined to certain parts. The different forms of projections may be made integrally with, or attached to, the hull. They may be hollow and built up of plates; in smaller vessels, pneumatically-inflated projections can be used. They may be wholly or partly filled with cork, wood, or any solid or liquid filling. They act as stiffeners to the hull against hogging, sagging and crushing strains.

24,558.—DRIVING-GEAR FOR SCREW PROPELLERS. E. MASSON, GRAVELINES, FRANCE.

Relates to the propulsion of navigable vessels of that class in which the stuffing-boxes for the propeller shafts are dispensed with, the shafts

rotating in tubes open to the water. The mechanism, which is driven by a sprocket-wheel provided with cranks and pedals, consists of bevel pinions, driving a vertical shaft, housed in a tube, and a horizontal shaft, through bevel gearing. The horizontal shaft is mounted in bearings above which are fitted inspection doors. The vertical shaft is carried by an adjustable bearing, regulated by screws fixed to the tube, and a footstep bearing. All bearings are either roller or ball bearings.

International Marine Engineering

JULY, 1908.

NEW JAPANESE TRANSPACIFIC LINERS.

With the sailing from Hong Kong on June 2 of the steamship *Tenyo Maru*, and the approaching completion of her sister ship, *Chiyo Maru*, there has been begun a new service to San Francisco of the Toyo Kisen Kaisha (Oriental Steamship Company). These two ships, and a third now building, are the largest ever built in Japan, and are the first so built to be fitted with steam turbines. They are of about 13,500 tons gross register, and are propelled by triple screws, each actuated by a turbine of the Parsons type. The central screw is operated by a high-pressure turbine with a rotor 76 inches in diameter. The two low-pressure rotors are 106 inches in diameter and operate the side screws. Each shaft has a diameter of 12 1/16 inches. The reversing turbines, which are of ample power to assure efficient maneuvering, are, as usual, incorporated in the low-pressure casings. The turbines are designed for a working boiler pressure of 180 pounds per square inch, and will develop about 17,000 horsepower at a speed of 270 revolutions per minute. This is expected to give the ships a trial speed of 20 knots and a continuous sea speed of 18 knots. The propellers are three-bladed and of small diameter.

The steam generating plant consists of thirteen single-ended Scotch boilers, with a diameter of 15 feet 9 inches and a length of 11 feet 6 inches. Each boiler has four Morison suspension furnaces, and is operated under Howden's forced draft. The aggregate heating surface is 37,660 square feet, or 2.21 feet per designed indicated horsepower. The boilers are arranged in two compartments, separated by watertight bulkheads, and each set discharges the products of combustion into a funnel of elliptical shape, having major and minor axes 12½ and 9½ feet, respectively. Liquid fuel will be used.

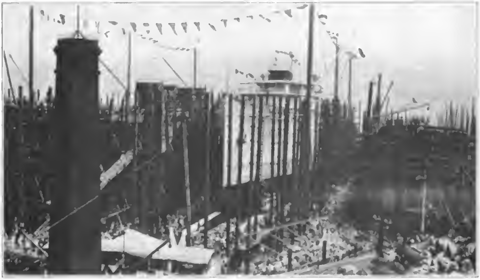
The auxiliary engines in the engine room are in nearly all cases fitted in duplicate as a protection against possible breakdown. There are in all twenty-eight sets of pumps, three evaporators and one duplex distiller. The electric generating plant consists of two 75-kilowatt dynamos driven by compound engines. The wiring is done on the double distribution box system, and arranged so as to be accessible in all parts of the ship.

These vessels have a length over all of 575 feet; a length between perpendiculars of 550 feet; and a molded beam of 63 feet. The depth molded to upper deck is 38 feet 6 inches, and 46 feet 6 inches to shelter deck. The height between these two decks is thus seen to be 8 feet. From the shelter to the promenade deck the height is 9 feet; from the promenade to the boat deck it is also 9 feet. With a maximum draft of 31 feet 8 inches the displacement is 21,650 tons.

THE NEW TURBINE-DRIVEN TRIPLE SCREW STEAMSHIP TENYO MARU.

Provision is made for 275 first class passengers, 54 intermediate passengers and 800 in the steerage. As these ships are to be operated in large measure in tropical waters and on a long run, the greatest attention has been paid to the arrangement of the quarters for these various grades of passengers. Among other things is the provision of ample promenade space and liberal proportions in the living quarters. The ventilation system is said to be such as to insure fresh air, no matter what the weather. Each room is fitted with an electric fan and electric lights, while the system of heating may be controlled by each passenger in his own state room.

The two upper decks (boat and promenade) are devoted entirely to first class accommodations. The shelter deck is the weather deck, and carries cargo gear at the forward and after ends. Amidships, under a deckhouse 280 feet long, are the



THE LAUNCHING OF THE STEAMSHIP TENYO MARU; THE SHIP LEAVING THE WAYS.

first class cabins and dining saloon. On the upper deck are quarters for the intermediate passengers, with a few first class cabins amidships. The main and lower decks are fitted largely for cargo stowage. The top of the shaft tunnels forms the lower deck and bottom of the after holds.

The first class passengers are accommodated in ninety-six state rooms, in nearly all of which the 9-foot head room rules. On the promenade deck are four suites, containing in each case bed room, parlor, bath room and toilet. In addition to these suites are several so-called family rooms, containing two beds and one sofa, the latter being so arranged that it may be used as another berth. Each of these family rooms is en suite with another room, which can be used as a sitting room, and is provided with ample closet space. Inner rooms have been avoided except on the upper deck, where the state rooms have only one berth. In the furnishing of the rooms, brass and mahogany have been used extensively, and all of the appointments have been designed with an eye to their artistic qualities. All the passageways and alcoves in the first class accommodations are tiled with patent india rubber.

The intermediate passengers are quartered in two-berth rooms, which are simply but comfortably furnished, and are provided with efficient heating and ventilation. These passengers have a large dining saloon, a ladies' room and a smoking room. The Japanese steerage is forward and the Chinese steerage aft on the main deck. The ventilation and sanitation are carefully provided for, and in cold weather the steerages are heated by the thermotank system.

The purser and bureau of inquiry are located on the shelter deck, at the after end of which is a hospital and dispensary. On the upper deck is a printing office, from which will be published a daily paper containing news received by the wireless telegraph equipment. The commissary departments are very elaborate, electricity playing an important part. The refrigerating plant insures a constant supply of fresh food. There are separate galleys for the Chinese and Japanese steerage passengers.

For the carrying of cargo the ship has six holds of nearly equal capacity, reached by eight hatchways. Each hatchway is provided with two winches furnished by Clarke, Chapman &

THE LAUNCHING OF THE STEAMSHIP TENYO MARU; THE SHIP TAKING THE WATER.

THE SHIP AFLOAT.

Company. There are in addition two 25-ton derricks for the handling of heavy weights. Twin capstans are fitted at the forward and after ends of the shelter deck. The anchor cables are 2⅞ inches in diameter, and operate four Hall patent stockless anchors. The anchors and cables weigh 90 tons.

STERN VIEW OF TENYO MARU ON THE WAYS.

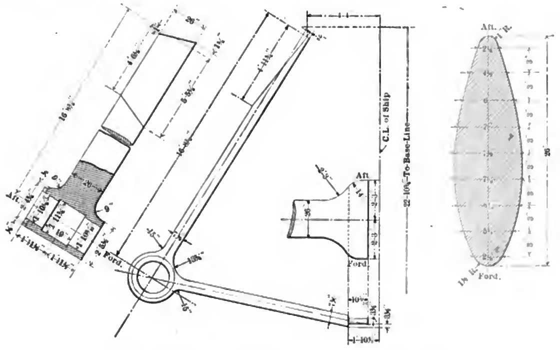
There is telephonic connection between all working parts of the ship. The watertight doors to the numerous bulkheads are installed on the "Long-Arm" system, and in an emergency can all be closed simultaneously from the bridge.

Among the other features might be mentioned a well-equipped gymnasium, a nursery, an auxiliary saloon, where private parties can be given, a dark room, a dancing floor on the after-part of one of the decks, with the piano at convenient command, a lounging room where both coffee and cigars may be enjoyed, and the usual public rooms to be found on all vessels of the present day.

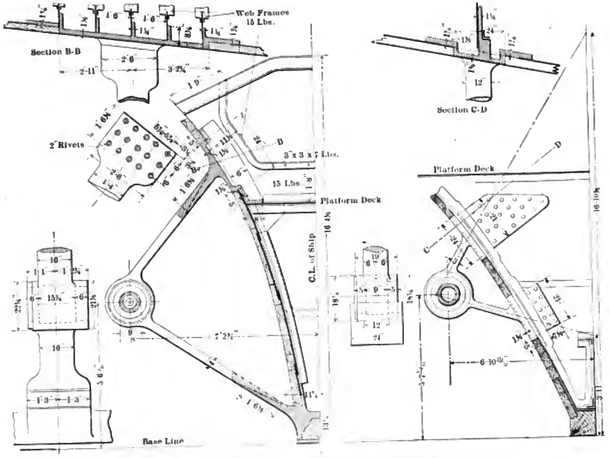
All three ships are products of the Mitsubishi Dockyard & Engine Works, at Nagasaki, and have been built to conform with the requirements of Lloyd's and of the Japanese government (as auxiliary cruisers). The turbines for the first two vessels have been constructed by the Parsons Marine Steam Turbine Company, Wallsend-on-Tyne. The turbines for the third vessel are being constructed by the Mitsubishi Company under license.

The keel of the *Tenyo Maru* was laid in November, 1905, but delays in the transfer of raw materials from England held her back for possibly six months. About 8,000 tons of steel were worked into her before launching, which makes her the heaviest ship ever launched in Japan, or into the Pacific or Indian Ocean. She is the largest merchant steamer launched into these oceans, and also the largest turbine-driven passenger steamer built outside of Great Britain. Each ship has been so designed as to be used as an auxiliary cruiser in case of war, the armament to consist of six 6-inch, ten 3-inch and four machine guns.

The report of the Bureau of Navigation of the Department of Commerce and Labor shows that during the month of April there were constructed in the United States 114 steam and sailing vessels, aggregating 63,176 gross tons. Eight of these vessels, of which five were on the Great Lakes, account for 46,152 tons or 73 percent of the total. Five of these vessels, including the three largest, were built on the Great Lakes, while two were built on the Delaware River and one at San Francisco. In the total list the steel steamers account for sixteen vessels of 52,217 gross tons, or an average of 3,264. For May the figures were 116 vessels and 51,401 tons, of which ten steel steamers accounted for 43,952 tons.



DETAIL OF THE PROPELLER STRUTS OF THE UNITED STATES BATTLESHIP OHIO.

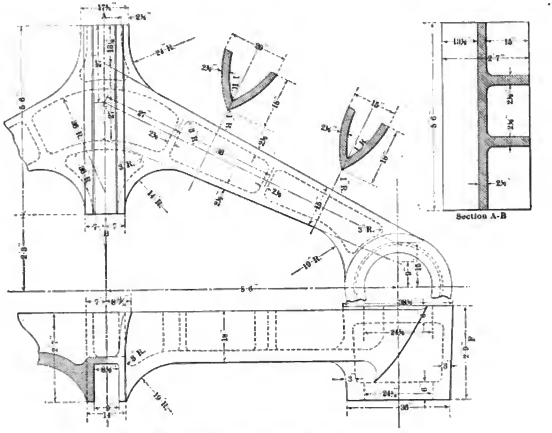


FORWARD AND AFTER PROPELLER STRUTS OF THE SHEATHED SEMI-PROTECTED CRUISER TACOMA.

A FEW CONSTRUCTIVE DETAILS.

SPECTACLE FRAMES AND PROPELLER STRUTS.

These two items are similar in applieation, though different in detail. The spectacle frame of the steamships *Mexican* and *Columbian* is made of cast steel, and the rough



THE SPECTACLE FRAMES FOR PROPELLER SUPPORT, ON THE STEAMSHIP MEXICAN.

casting weighed about 21,000 pounds. The center line of the boss for the propeller shaft is 8 feet 6 inches from the center line of the ship, and is 2 feet 3 inches below the bottom of the central part of the casting, which is 5 feet 6 inches deep. The fore-and-aft length of the casting proper is 2 feet 7 inches at the center line, and 2 feet 9 inches at the boss; the intermediate section has a fore-and-aft dimension of 18 inches, the boss has a diameter aft of 36 inches, and forward of 38½ inches.

The after struts on the battleship *Ohio* are of cast steel, and weigh each 18,830 pounds. The center of the boss is 8 feet 3 inches above the base line of the ship, and 13 feet out from the center line. The boss has a length of 3 feet 11 inches. The upper and lower arms of the strut are similar in section, measuring 26 by 7½ inches, as shown in the sectional view. The center line of the lower arm meets the center line of the ship 5 feet 7⅝ inches above the base line.

The struts of the sheathed, semi-protected cruiser *Tacoma* are shown in another drawing. They are of manganese bronze, the after struts weighing 7,623 pounds each, and the forward struts 3,927 pounds each. The after struts have a section in each arm measuring 16 by 4 inches, and the forward struts 12 by 3 inches, each being an elongated egg-shaped form. The center line of the boss at the after strut is 7 feet 2⅝ inches out from the center line of the ship, and 5 feet 6 5/16 inches above the base line. This boss is 2 feet 3¾ inches long. The center line of the boss of the forward strut is 6 feet 10 21/32 inches out from the center line of the ship, and 5 feet 7⅞ inches above the base line. This boss is 19 inches long.

(To be Concluded.)

SAIL MAKING.

BY ADRIAN WILSON.

The setting of topsails is almost a chapter in itself, so few realize the importance of knowing how to set topsails. After setting the mainsail, many skippers will loose out the topsail and (1) sheet it out to end of gaff; (2) hoist it up as far as possible, and (3) try to tack it down, which after the first two operations is simply an impossibility and eannot be accomplished. Referring to Fig. 16, remember that a jib-headed topsail is a triangular sail, the same as a jib. The topsail should be set as follows: (1) Hoist sail; (2) tack down—and the tack should always be provided with a good, strong purchase; that is, a reef tackle purchase, or tacked down at the winch, if there is one on the mast for such purposes—and last of all, it should be sheeted out. The sail should be so hoisted and tacked down that when sheeted out the clew is exactly in a right angle drawn from the end of the gaff to the topmast, as indicated by line marked *A* (Fig. 16). If the sail is hoisted so high on the topmast that when sheeted out the clew is above the line *A*, the sheet pulls down the leach, and not only makes a tight leach, but the foot is not taut, and will always flow away to leeward. We very often have complaints that the foot is too long and they cannot get it to set. This is the reason:

If the sail is not hoisted high enough the opposite occurs, and the foot is too tight and the leach slack (Figs. 17 and 18).

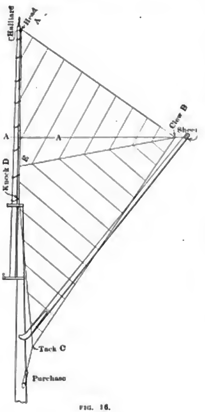


FIG. 16.

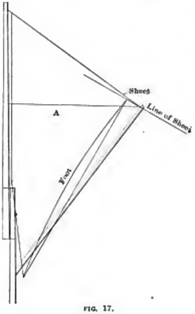


FIG. 17.

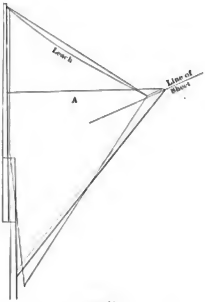


FIG. 18.

If we were to ask a sailing master to haul the jib sheet taut before the jib was hoisted to its place, very probably he would laugh at us and say it was an impossible thing to do. So it is with the topsail. It is a triangular sail, the same as the jib, and should be stretched on its luff before it is pulled out on the sheet. The object to be attained in setting the topsail is to put an equal strain on all three sides of the sail.

It makes no difference if the topsail is cut with cloths parallel to the leach or at right angles to leach and foot, the greatest stretch in a topsail comes on the line *F* to *B*, Fig. 19, as this is directly on a diagonal of the cloth, and gives easily to a strain, so if the sail be sheeted out too far or too hard by the sheet, the clew *B*, instead of being at its designed point, is extended to a point represented by *G*, Fig. 19, and the sail is pulled out of shape. If the sail be hoisted to point *A*, then tacked down to point *C*, when the purchase is put on the sheet, the leach and foot will take an equal strain and the diagonal *F* to *B* will not be over-stretched, and the topsail will fit and set. It is a difficult matter to tell exactly when the sail is hoisted to the proper height on the topmast, and it is better to make several attempts and get it right than go ahead and spoil it and have an unsatisfactory sail or blame the sailmaker. Either go aloft on the mast-head and see that the clew *B* is on a right angle from mast to end of gaff, or, what is better, go off a little distance from the yacht in a small boat, and at a point at a right angle to the yacht, when you can always see if the sail is at its proper height in relation to the right angle. Then you will have a satisfactory sail, and save yourself and the sailmaker a lot of annoyance. The result will more than repay the trouble taken. By doing this you get the position of the distance the tack comes below the jaws of the gaff, after which you can set the topsail without trouble. We have so many complaints that the foot of a topsail will not stand flat, but flow off from the gaff, and it is always caused by setting the topsail too high.

When the sail is new, remember that your mainsail is new. The peak is stretching up and the topsail stretches out. Considerable allowance has to be made in sail for this stretching, and the topsail is considerably smaller than the space it is finally intended to fill, and care must be taken to see that it is set in the proper position at first. The mainsail will stretch up. Consequently, the allowance for stretch on mainsail must be taken into consideration, and whatever the mainsail goes up

THE SCHOONER YACHT TAORMINA IN WINDWARD WORK.
(Photograph by N. L. Stebbins.)

so the whole topsail will go up with it. In addition, some allowance is made for stretch on luff of topsail, so it will not do to hoist the sail two blocks over a new mainsail. (See plan of mainsail and topsail for new sails, with allowance for stretch of both sails, Fig. 20.) Here cau be seen the position of these sails as they should be set by the dotted lines, which

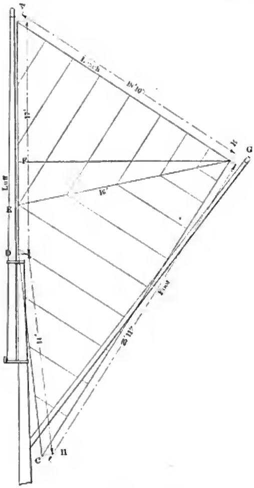


FIG. 19.

represent the new sails, with proper allowance made for stretching.

Now, let us take the foresail. I have taken the rig of a schooner to illustrate the setting of sails. It is a strange fact that, as a rule, the practice is not to set the peak of the mainsail enough, and to invariably overset the peak of the foresail. The foresail is a tall, narrow sail, and the boom and gaff are relatively light spars as compared with the main, and it is a very easy matter to set the peak too high. We want to suggest the following practice in setting the foresail: The luff or hoist should be set to its proper height with gaff hanging at about a right angle to the mast. Refer to Fig. 21, with luff set as suggested above. There should come a fair amount of strain on the diagonal. Suppose that the topping lift has been slacked. Now make the foresheet fast. After the sheet is belayed, peak the sail up until it becomes perfectly smooth and flat in its after part or leach. By setting the sail in this manner you do not overset the peak.

As I have said, the foresail, with its boom and gaff, is light, and it is a very easy matter to overset it. If the sail is set without belaying the sheet, it may be very easily overset, as shown by dotted lines in Fig. 21, and the result will be that the sail, instead of being spread out flat and smooth, will hang from the end of gaff, and the leach will be a perfect bag. Also, the gaff will have a tendency to swing off to leeward, so much so that it will be impossible to make a topsail stand on it without the topsail showing a decided tendency to flap. The gaff, swinging off so far, causes the upper part of topsail to be right in the wind. The over-peaking of foresail also throws the topsail almost completely out, as the distance from mast to end of gaff is thereby shortened (lines *A-B* and *A'-B'*) so much that it is impossible to sheet the topsail. We have often complaints of the foresail stretching up so much that the end of the gaff when tacking fouls the spring stay, when in reality the fact is that it has been simply a matter of setting the peak too high. We have often been called on board a yacht to look at the foresail, and on having the sail properly set we find the end of the gaff will clear the spring stay from 18 inches to 2 feet.

We have, to a very great extent, overcome the difficulty in setting headsails by fitting the luff with steel wire rope in place of the hemp bolt rope. Often the case will be that the leach of a jib is too free and is inclined to whip. If fitted with a hemp luff rope it is more than likely that the sail is not properly hoisted, and often a pull on the halyard will remedy this fault, but the extra pull on the halyard should not be taken until the sheet has been slacked, as it is impossible to get the luff to its right place under these conditions, for the same reason as I have already explained in regard to the gaff topsail sheets. Also of great importance is the lead of the sheet.

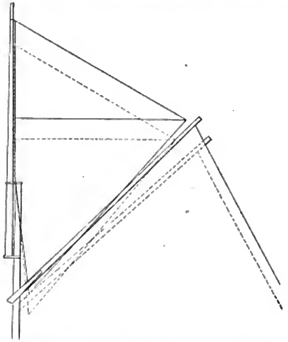


FIG. 20.—FULL LINES SHOW STRETCHED SAIL. DOTTED LINES SHOW SAIL WHEN NEW AND FIRST SET.

Great care should be taken in planning head sails, particularly in regard to location of clew. Head sails have presented the hardest problem that the sailmaker has had to solve. He not only has had to work out the problem of making the sail, but he has also had to work out with the designer the proper proportions that a headsail should be in order to do the best work. My personal experience has taught me that the best headsails are those that are cut with high clews, both in the jib and forestaysail. The position of the clew should be so located that the lead of the sheet will be to a point on deck, or at the rail, that is not only going to be convenient, but also

it must, above all, be so located that the sail will do its best and most efficient work.

On the small-class yachts it is an easy matter to get the proper location of the jib sheet leaders in the following manner: Hoist the jib to its proper height on the luff, and by a temporary sheet fastened in the clew of the sail lead this aft to a point on rail so that you are bringing an exact, even strain on both leach and foot. Now, by going just a trifle further aft with your sheet, you relieve the strain on leach of sail, insuring a good, free leach. The sail when filled with wind will rise a little above the line of the point first found. This plan works in all headsails, but the same idea of the lead of the sheet in setting topsails will not work out in headsails, as the point of contact of the sheet to deck or rail is not on a right angle to the stay.

On larger craft, when it is not practical to find the true lead as above, it will be found necessary to locate the leads from the sail plan. As can be seen by referring to Fig. 22, a plan that works out all right for a forestaysail and jib will not apply to a jibtopsail. The sheet for the jibtopsail will lead at nearly a right angle from the stay, intersecting the clew of the sail. As the jibtopsail sheet can be shifted fore or aft on the deck, this can be adjusted to get both leach and foot to

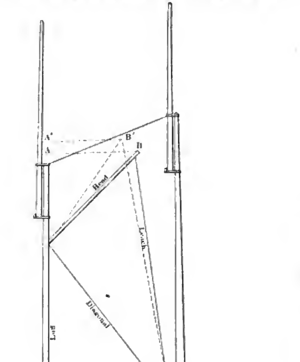


FIG. 21.

stand as desired. The location for forestaysail and jib sheet can also be found by drawing a line on the plan, starting from point A (Fig. 22) at the luff, and intersecting the clew of the sail at C. This point A should be about one-third of the distance of luff from tack. Where this line ends on the deck at E will be the correct place for the leads of forestaysail, and where it ends at rail E for the jib.

Another important point in headsails is to use great care in designing them, that they will not be too large for the spaces they fill; that is, to avoid having one headsail overlap another The forestaysail should not be longer on the foot than the distance from the stay to the mast. The clew should not come aft of the mast. In fact, if the clew in tacking swings entirely clear of the mast, the sail will do better work. The jib should overlap the forestaysail only a very little, as the luffs and

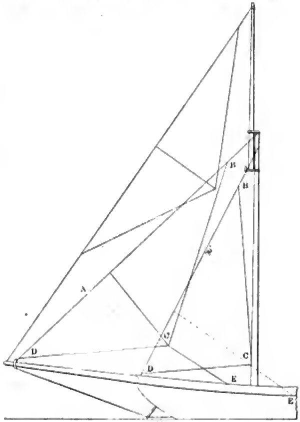


FIG. 22.

leach near the heads or upper parts are coming close to each other, and the wind, passing from the outer sail, will strike the one next aft and cause it to lift from the lee side, which, of course, is to be avoided.

Balloon sails, also, should not be cut too large, especially a balloon jibtopsail. My experience has been that very often the best work of a balloon jibtopsail can be had by not giving it too much lap by the mast, or having its foot cut too low. If this sail is too long on the foot it is impossible to trim it so as to avoid a considerable curve to the foot, which will have a tendency to cause the current of wind to flow back onto the lee side of the after lower sails, a condition certainly to be avoided. Many racing men differ as to the size of the spinnaker; but the majority do not want this too large, and I agree with them on this point. I believe it has been demonstrated in our restricted classes, where the spinnaker can be of only a certain area, as prescribed by the rule, that by having the boom set from 5 to 6 feet above the deck, and the sail hoisted to the top of the mast, and the foot of sail well above water, better results are attained than by using a shorter boom set near the deck, and the foot of the sail close to the water.

So far, what we have had to say about sails and sailmaking has applied only to sails of the fore-and-aft rig. It is not our purpose in this article to go into a description of other rigs, as it is for the benefit of the yachtsman of to-day that we have written what we have on the subject, and the fore-and-aft rig is the only one that will interest him. The fore-and-aft rig has become universal with yachtsmen, on account of its superior windward work, and it is also much handier and more easily managed than other rigs; but there are other rigs that are also

fast for windward work. It must not be taken for granted that the sloop or schooner rig is away and beyond all question faster in windward work than all others. It may be a surprising statement to some who read these lines to learn that a great many square-rigged vessels are remarkably fast in windward work. While the square-rigger may not point as near the wind as the fore-and-after, still there are many that have made remarkable records in windward work. Of the different square rigs in use, such as the full rigged ship, the bark, the brig and the hermaphrodite brig or half-rigged brig, the latter rig has produced in the past many fast-sailing vessels, particularly in windward work.

I have known several of these brigs that in the open sea, where they had the chance to work in tacking, would beat out a fleet of fore-and-afters in a day's work to windward. The plan here given of the brigantine *John McDermott* (Fig. 23) is an instance. This brig has shown marked windward ability, and possibly the position of her spars had a great deal to do with this. In this relation let me call attention to the fact that a square-rigger, when braced up as sharp as possible on the wind, presents an example of our idea of draft in fore-and-aft sails from the very position of her yards in their relation to the center line of the mast, that carries out in the square sail just the same idea that we have tried to illustrate in the fore-and-aft sail. That the upper yards are not braced to such a sharp angle as the lower yards gives the square sail on each mast the same effect or curve as the mainsail or foresail of a schooner.

To illustrate: Suppose we were on the royal yard and looking down on the lower yards in succession, we would see that they are not all braced alike, but as seen in the illustration of the barkentine *Rachel Emery*. Also it will be seen that these sails present a series of curves; and could they be made with the same care and handled with the same skill as the sails on a yacht, they would prove surprisingly fast in windward work. It is a fact that, while the square-rigger will not point so high or so near the wind as the fore-and-after, the reaching quality of her sails produces a very fast vessel, and she makes up in reaching what she lacks in pointing. Herein lays a point that every amateur should note. It is almost a universal fault that the amateur will invariably try to point his boat too near the wind and starve her, whereas, if he would only keep the sails full of wind the boat will every time reach faster, and make the windward work in less time. If the sails are kept full the boat will fairly work out to windward sideways; but if held too high or pointed too near to the wind will make some considerable leeway. The barkentine is also a good rig for windward work. I do not mean to make the statement that the square rig is as good as or the equal of the fore-and-aft; but that many square-rigged vessels are remarkably fast in windward work is the fact. The fore-and-aft rig presents many advantages, it being simpler and much more easily handled, and needs fewer men than the other rigs. There are also the lateen and lug rigs.

The handling and care of sails is a very important item. It has always been the custom to haul sails out on the boom and gaff and make them fast to the spars permanently. The mainsail and foresail on a yacht should be slacked in on the boom and gaff when not in use. If the sail is at all damp or wet, it puts an undue strain on the head and foot ropes, and if allowed to stand in this condition until it dries, or for some time, it becomes stretched, which should not be allowed to happen; so it is safe to slack the lashings at the end of the gaff, and slack up the outhaul on foot when furling the sail, so that it may dry out without being strained. Also, in furling sails it is a custom to roll the sail up tight and snug. This should be avoided. The sail, as it is lowered down, should be folded back and forth across the top of the boom, and secured with the sail stops. The stops should not be put between the foot rope and the boom, but should pass over the gaff and under the boom. If placed between the foot rope and the boom, the stops, when pulled taut, stretch the foot rope, which should be avoided.

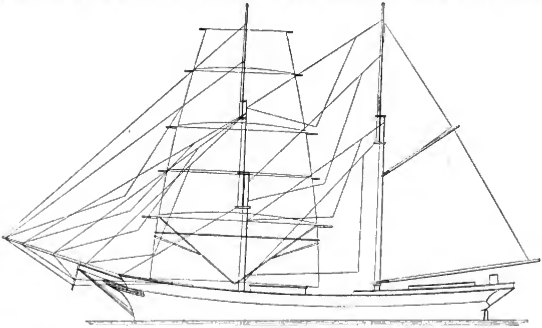


FIG. 23.—SAIL PLAN OF THE HERMAPHRODITE OR HALF-BRIG JOHN MCDERMOTT.

Sails when dried after being wet should be hoisted, if possible, to their exact shape, so that all parts of the canvas will be subject to the same strain. Then all parts will dry with an even strain, and should dry out alike. A great many different processes have been tried to keep sails from mildewing, some of which are very detrimental to the canvas. The best thing for new sails is to soak them in clean sea water; but the sails should be used for several days before doing anything of this kind to them, in order that all parts of the sails may be able to adjust themselves to the strains caused by the actual winds. Great care should also be used as to what conditions a sail is subject to when first used. It is better to exercise great

THE BARKENTINE RACHEL EMERY. A GOOD SAIL, SHOWING DRAFT IN LUFF. ROSE DOROTHEA.
(Photographs by N. L. Stebbins.)

patience in this and give the sail the benefit of the greatest care, as sail should be set the first time only under the most favorable conditions, and these are a moderately warm day with light winds. Under no condition should a sail be reefed when first set, if we expect to get the best out of it.

For mildew-proofing the following formula will be found to be a very good one and will not injure the canvas: Dissolve 1 pound sulphate of zinc in 40 gallons of water; add 1 pound sodium carbonate. When dissolved, add 2 ounces tartaric acid. This holds the partially separate zinc carbonate without neutralizing the excess of the alkali. The canvas should be soaked in this solution for twenty-four hours. Then dry without wringing.

As I have already said, more poor sails are made on yachts, by improper or careless handling, than are made in sail lofts. So I trust what has been written here may be of benefit to our friends and customers, and, if so, we shall feel that a duty has been accomplished which, while costing us no great effort, may be of value to all who are interested in the sailing yacht—large or small.

Totally Dismasted.

The illustrations depict one of the most unique marine disasters of recent years. They are taken from photographs of the dismasted schooner *Sarah W. Lawrence*, of Manasquan, N. J., just after that vessel was towed into Norfolk, Va., by the United States revenue cutter *Onondaga*, in the latter part of January. The *Lawrence* is a four-masted vessel of 1,301 tons register, 217 feet long, 45 feet wide and 19 feet deep, and carries a crew of ten men, including the captain; she is one of the pioneers of the large present-day fleet of monster coasting schooners, having been built in 1886 at Bath, Maine, and engaged in the coal-carrying trade ever since.

While on her way from an eastern port to Newport News she was struck by the blizzard of Jan. 23, and leveled to the deck, not even the stump of one of her lofty masts projecting above the bulwarks. When the storm struck, her captain, one of the ablest and most experienced of coastwise navigators, shortened sail until only the fore staysail was left, and finally, when it became unsafe to run longer, anchored in twenty-five fathoms of water some 26 miles to the eastward of

THE SARAH W. LAWRENCE WAS TOWED INTO NORFOLK HARBOR TOTALLY DISMASTED.

Winter Quarter Shoal lightship, off the coast of Virginia, and veered all the chain. The vessel was equipped with unusually good ground tackle, which held her even in that exposed position, where the wind had a clear sweep of more than a hundred and fifty miles, and the seas were breaking over her bows, though she was without cargo and high out of the water.

The sails were all furled, the booms lowered to the deck to relieve the masts as much as possible, and every precaution taken to insure the safety of the vessel. The wind and sea were terrific in their violence, and the spray which was flying froze wherever it struck, adding a weight of ice to the already overburdened spars and rigging, until, early on Friday night (the 24th) the vessel pitched so heavily that the rigging could stand the strain no longer, and the bobstays carried away; the fore and main masts fell together, followed the next minute by the two after masts in succession. As the huge sticks fell, they crushed everything in their path until they reached the huge black hull looming above the horizon. Coming up alongside the schooner, a boat was lowered, though a heavy sea was still running, and a hawser taken on board and made fast. Upon going ahead the hawser, an 11-inch manila line, was chafed in two by the jagged pieces of bowsprit projecting from the *Lawrence's* bow. The sea became rougher, and nothing more could be done that night, so the schooner was anchored again, and the *Onondaga* stood by until daylight the next morning, when the line was run again, and again chafed in two. The schooner's starboard anchor chain was then laboriously unshackled, and the hawser made fast to its end. After a few minutes of pulling, the hawser parted and the tiresome work had to be done anew. This time the line held and the *Onondaga* and her tow proceeded toward the Chesapeake. All that day (Sunday, 26th) the wind and sea increased, until by 8 o'clock in the evening it was blowing a strong gale, and the sea was very heavy. Added to this, some of the wreckage hanging over the schooner's stern fouled her rudder,

A SCENE OF DEVASTATION—THE AFTER DECK OF THE SCHOONER SARAH W. LAWRENCE.

solid timbers of the vessel's hull. A great crescent-shaped hole was smashed in the stern, extending down to the transom beam; deck houses were splintered, bitts broken, rails demolished, and the decks covered with an almost inextricable mass of spars, sails, running and standing rigging and wreckage. The two boats which the schooner carried were also destroyed.

Miraculously no one was injured, the crew being all below decks except one man, who contrived to reach the after cabin companionway in time to avoid being struck by the masts in their descent. The masts were securely imbedded in the bulwarks and hull where they struck, and the frightful consequences of having them adrift and rolling about on the decks were thus averted, but, shocked by the terrifying catastrophe and with their lives now dependent only upon the anchor and chain, out of sight of land, at the very height ot the stormiest season of winter, theirs was an unenviable lot.

On Saturday, the *Onondaga*, having herself ridden out the gale off the Delaware capes, was proceeding southward, when she sighted the *Lawrence*, a strange-looking craft, with her and it was only by heroic effort that she could be steered at all. As it was, she yawed about in the sea until about 10 o'clock the hawser parted, and the vessel was compelled to anchor again, while the cutter stood by that night, all the next day and the next night, waiting for the sea to moderate sufficiently to permit a boat to be lowered to take the hawser to the schooner.

At daylight on Tuesday morning the surf boat from the *Onondaga* succeeded in running a line to the *Lawrence*, and she was taken in tow once more. From this on, the weather conditions continued to improve, and shortly after dark the vessels passed in the Chesapeake Capes, and the *Lawrence* was anchored in Hampton Roads.

Shipping men in Norfolk, where the schooner was towed the next day, say that she was the most completely disabled craft ever seen in that vicinity, and throngs of curious people visited her while she was at anchor in the harbor.

A certain number of public vessels (revenue cutters) are designated to patrol the stormy parts of the American coasts during the winter months, to render assistance, whenever

necessary, to distressed mariners, and the wisdom of this provision has perhaps never been more strikingly shown than in this case, which has attracted widespread attention, both in maritime circles and elsewhere, reflecting great credit upon Lieutenant At Lee, U. S. R. C. S., who commanded the *Onondaga*, and upon the revenue cutter service. Captain Moore and the crew of the *Sarah W. Lawrence* expressed much admiration for what they called the "bull-dog tenacity" with which the *Onondaga* hung on in the face of many difficulties experienced in effecting their rescue from what was indeed a perilous predicament.

THE HEATING AND VENTILATING OF SHIPS.

BY SYDNEY F. WALKER, M. I. E. E.

HEATING BY ELECTRICITY.

All electrical heating apparatus is based upon the fact that, when an electric current passes through a conductor, heat is liberated in direct proportion to the resistance of the conductor and to the square of the strength of the current. The formula is $H = tRC^2$, where H is the quantity of heat liberated in time t, C is the current strength in amperes, and R is the resistance of the conductor in ohms. The formula may also be written,

$$H = ECt, \text{ or } H = \frac{E^2t}{R},$$

where E is the difference of pressure in volts at the terminals of the conductor. Connection is made with the thermal system by the fact that H is expressed in watts, the electrical unit of the rate of expenditure of energy, and that 17.58 watts equals one B. T. U. This matter is referred to again further on.

Heating takes place in all forms of electrical apparatus, in cables, in the conductors forming part of the coils of dynamos, motors, etc., and also in all forms of electric lamps. But, in the case of cables and conductors forming parts of dynamos and motors, the heat is kept as low as possible, and in the case of lamps, the great object striven for is to obtain as large a conversion as possible of the heat waves into light waves. In heating apparatus the great object to be attained is of course heat, and therefore all electrical heating apparatus is designed with a high resistance, so that as large a quantity of heat shall be liberated as possible, within a given space.

Electrical heating apparatus has so far divided itself into two main branches, the luminous and non-luminous. Luminous electrical heating apparatus is merely an extension of the well-known electric incandescent lamp. The current passing through the filament of such a lamp, it will be remembered, first liberates heat; and if the current is not of a certain definite strength, only heat will be liberated, and the lamp filament remains black, but it is still giving out some heat, though the pressure is too low for the lamp in question. When the pressure and the temperature are a little higher, the lamp becomes red, a larger amount of heat is given out, and the small quantity of light possessed by the red rays. As the pressure and the current are increased, the lamp becomes gradually brighter, finally assuming the well-known yellow tinge, or, if allowed, becoming white hot. In all cases, however, whatever the color of the filament, and whatever the temperature to which it may be raised, the whole of the electrical energy delivered to it eventually becomes heat, and is delivered to the air of the room in which the lamp is fixed.

Under ordinary circumstances, the carbon filament incandescent lamp converts from about 3 to 5 percent of its heat into light, but the light rays are, so far as is known at present, reconverted into heat in the room. The action is the same as the action of the sun's rays upon a greenhouse. It is well known that it is the light rays of the sun which cause the heating effect in the greenhouse, very much more largely than the heat rays. Glass is transparent to light rays, and they pass through the glass into the greenhouse, as through the glass of the incandescent electric lamp, and are converted into heat waves on the other side. In the case of the greenhouse, as glass resists the passage of heat rays through it, the converted light rays cannot escape so easily as they passed into the greenhouse, and the temperature is raised. Similarly, the light rays from the incandescent electric lamp become heat rays on passing out into the room, and the remainder of the electrical energy delivered to the filament becomes heat within the filament globe, and heats the globe in the well-known manner, the heat being then transmitted to the air of the room in the usual way.

Consideration of the two types of heaters, luminous and non-luminous, makes it evident that where *continuous service* is desired, a heater which depends on the setting up and circulation of air currents passing through it gives the best results. If *immediate heat* is required the luminous radiator is practically instantaneous. It heats the person rather than the air in the room, the latter being warmed only indirectly from the heated surfaces on which the rays from the radiator may fall. For immediate, localized heat, for warming the person, it has no superior, and this fact often permits the use of electric heat where it would otherwise be far too expensive. This distinction should be clearly emphasized if an intelligent application of the two forms is to be made.

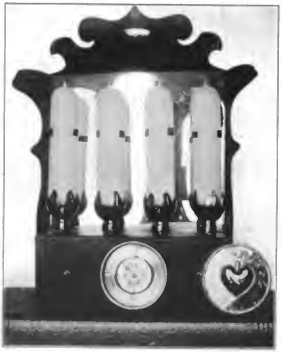


FIG. 19.—GLOW-LAMP RADIATOR AND METER. BAPPLIES, LTD.

ELECTRIC HEATING APPLIANCES ON SHIPBOARD.

Recognizing the vast possibilities in the application of electricity to heating, many manufacturing electric companies have developed a variety of special devices which have already won such favor that it seems certain they will be as commonly used as the incandescent lamp. A ship's lighting plant, usually of more than ample capacity for its intermittent load, offers at once an available source of supply, which, utilized for cooking in the galley or heating in the staterooms, would provide numerous real and profitable conveniences with small increase in cost.

The electric heater is ideal for stateroom use. It is compact and neat in appearance, and easily turned on and off, thus admitting of regulation of temperature for each individual room. It is connected by simple wiring, which is more flexible than steam piping. The wires take little space and can be run anywhere, while steam pipes are bulky and apt to leak, and necessarily heat the spaces through which they pass. It is safe to say that the electric radiator, although deriving its heat indirectly from steam, is no less efficient, when the losses due to leakage and radiation are taken into consideration.

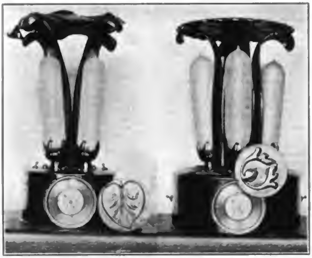


FIG. 20.—GLOW-LAMP RADIATORS WITH METERS ATTACHED.

GLOW-LAMP RADIATORS.

Forms of what are termed glow-lamp radiators are shown in Figs. 19 and 20. They are now well known, and consist of from two to four specially made carbon filament incandescent lamps, usually 9 inches long, with a single horseshoe filament, approximately double the length of the lamp; the two, three

FIG. 21. BRITISH THOMSON-HOUSTON EDISON RADIATOR LAMP.

or four lamps being held in some ornamental fitting, usually with a reflector behind them, and arranged to throw the whole of the rays from the lamp out into the room. The apparatus is fitted with switches, arranged to connect one, two, three or four lamps, as required, so that the heat delivered to the room may be regulated within these limits. Fig. 21 shows one of the lamps, by the British Thomson-Houston Company, and Fig. 22 shows King Edward's cabin on board the royal yacht, heated by one of Dowsing's luminous radiators.

Some makers are also providing electric radiators with glow lamps, of the pattern described, inside of various inclosures, the appearance being very much the same as that of the non-luminous radiators or convectors described further on. In one form, two or four lamps are inclosed inside a cylindrical copper or brass case, with perforations, the whole apparatus standing a little off the floor. The idea here is that the air passes under the apparatus, up over the lamps, and out through the perforations at the top and the side. This is shown in Fig. 23. Other forms are almost copies of the non-luminous ra-

FIG. 22.—KING EDWARD'S QUARTERS ON THE ROYAL YACHT VICTORIA AND ALBERT.

diators. They are rectangular in form and inclose two or four lamps inside a framework, raised slightly from the floor by feet, and the front of the apparatus being closed by slips of ruby glass, the effect is pretty. There are also other forms of this arrangement on something the same lines. The British Prometheus Company has also introduced glow-lamp radiators, in which the lamps are maintained at only red heat.

FIG. 23.—GLOW-LAMP RADIATOR.

THE EFFECT OF THE LIGHT RAYS.

It should perhaps be mentioned, *en passant*, that it is claimed by makers of glow lamp radiators that the light rays issuing from the glow lamps have an important office, and, in the writer's view, this is strictly correct. It will be remembered that white light is made up of the different colors forming the solar spectrum, as we see it in the rainbow, and that the rays forming the different colors have different wave lengths, different periods and different properties. Thus, the red rays have comparatively long waves, about double the length of the violet rays, and their property is principally heating. The violet rays at the opposite end of the spectrum have

comparatively short waves, and the principal property is actinic or chemical. It is the violet rays which are most useful in photography.

Between the violet and the red is a long range of rays of different colors, whose properties vary, most of them having been thoroughly worked out. Apparently the yellow rays are those which do most in the direction of furnishing light. Glass and some other substances, the human skin of the white man being one of them, according to some experiments that have been made, are apparently transparent to the yellow and green, and some of the other waves at that end of the spectrum, the waves after passing through the glass or the skin being transformed into heat waves. This has been mentioned as the cause of the heat produced in greenhouses when the sun is bright.

Mr. Dowsing's work also in connection with the use of the electric glow lamp, of the type described for heating, in connection with therapeutics, has shown that the light waves have a very important effect upon the human body. The electric light bath is now well known, and its effects are produced, it is believed, by the light rays issuing from the lamps, and

FIG. 24.—PROMETHEUS STATEROOM HEATER, ELEMENTS AND DETAILS.

not by the heat rays. Another peculiar feature about them is, according to Mr. Dowsing, that the pigment under the skin of the black man is not transparent to the light rays. Thus, one cannot give a black man an electric light bath. It does him no good. This would apparently be the reason why the black man can stand the sun's rays. It is not the heat rays which trouble the white man so much as the light rays, which pass through his skin, there becoming heat; while they do not pass through the pigment in the black man's skin.

It will be seen that this has an important bearing upon the question of the warming of living rooms, whether on shore or afloat. Everyone is familiar with the prejudice, as it is thought to be, in favor of a bright, glowing fire; and it is not the fire of red coals that is liked, but one in which white or yellow flames are dancing around the grate bars. If the above reasoning is correct, this tendency, like so many others, is well founded, and the light rays have an important function in the matter of heating. If so, also, the luminous radiator should have an important office to fulfil in the problem of heating saloons, cabins, etc. In the writer's experience, when away at sea, nothing is more pleasant than a bright light in the mess or in one's cabin, and a bright radiator will probably have the same effect.

The lamps in question consume one-quarter of a kilowatt per hour. That is to say, with the usual 100-volt service employed on board ship, each lamp would take 2½ amperes; a radiator of two lamps, suitable for a small cabin, 5 amperes; one of four lamps, suitable for a larger cabin, 10 amperes. The question of the quantity of heat liberated by the radiators will be dealt with further on.

NON-LUMINOUS HEATING APPARATUS.

In the other forms of electric heating apparatus, which are very numerous, conductors, or, as it would probably be more

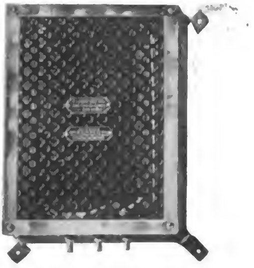


FIG. 25.—PROMETHEUS HEATER, WALL TYPE.

correct to call many of them, semi-conductors, are arranged in various forms, so that electric currents can be delivered to them, and so that the conductors, or semi-conductors, can deliver their heat to the air surrounding the apparatus.

One well-known form of non-luminous radiator, made both in America and the United Kingdom, is known as the Prometheus. It consists of strips of mica, upon which a conductor has been deposited in a layer or film. The strips of mica are provided with clips at the ends, in connection with the powdered conductor, and these clips form the connection to the source of current. Fig. 24 shows the heating elements. The mica strips with their clips, which are called heating elements, are built into various forms of apparatus, known as "convectors," some of which are shown in Figs. 25 and 26.

FIG. 26.—PROMETHEUS HEATER, FLOOR TYPE.

FIG. 27.—PROMETHEUS CONVECTOR.

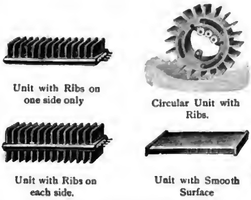


FIG. 28.—ISENTHAL'S HEATING ELEMENTS.

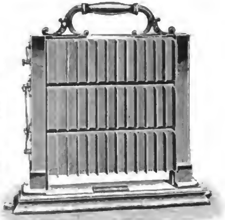


FIG 32.—ISENTHAL FLOOR-HEATING APPARATUS.

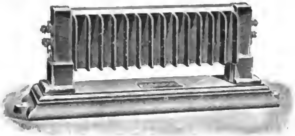


FIG. 31.—ISENTHAL FLOOR-HEATING APPARATUS.

In the usual arrangement there are two metallic uprights, forming the connection to the supply service, and the heating elements are bridged across between the uprights, the whole being inclosed inside of some ornamental arrangement, which may be cylindrical, rectangular or any other convenient form, and which usually has either perforations in the body and at the top, or the equivalent. The whole apparatus stands a little off the floor, the air passing under, up over the heating elements, and out into the surrounding atmosphere.

Another form, made by Messrs. Isenthal, consists of metallic resistances, inclosed within a substance which is an insulator, and which is also highly refractory. The metallic resistance is arranged to have low coefficients, both of expansion and of increase of resistance, so that there may be no change in the form of the heating elements when in use. The heating elements are sometimes made with ribs, as shown in Fig. 28, and there built up into circular or rectangular forms, as shown in Figs. 29 to 32, and inclosed in various ornamental devices, the arrangement being the same as that of the Prometheus. Other firms have other substances. Messrs. O. C. Hawkes, Ltd., London, have a special wire which they claim will stand a temperature of 1,000° F. The Simplex Electric Heating Company, Cambridge, Mass., uses conductor embedded in white enamel, which is fused at high temperature, the enamel providing the insulation and also being very refractory. The

FIG. 29.—CIRCULAR ELECTRIC HEATER.

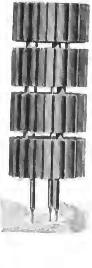


FIG. 30.—BATTERY FOR SAME.

Cartridge Unit. Quartz Enamel Unit.

FIG. 33.—GENERAL ELECTRIC HEATING ELEMENTS.

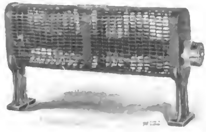


FIG. 34.—GENERAL ELECTRIC STATEROOM HEATER.

General Electric Company, Schenectady, uses a high resistance conductor, coiled into various forms, and covered with a highly-resisting quartz enamel. Forms of these heating elements are shown in Fig. 33, and a stateroom heater in Fig. 34.

(*To be Continued.*)

the United States Department of Commerce. In design and arrangement, special attention has been given to the requirements of the American emigrant trade. The vessel will be one of the most complete in this service.

Accommodation is provided for over sixty first class passengers in staterooms in the promenade deckhouse, with a large dining saloon, with music room and lounge adjoining, placed at the fore end of the deck house. Emigrant accommodation is arranged in the bridge deck house, in the poop, and on the main and lower decks forward and aft. The berths are fitted in blocks, two high, and accommodation is provided for about 2,500 persons. Dining spaces for emigrants, furnished with strong tables and forms, are arranged in the bridge space and on the main deck amidships. The sanitary arrangements throughout the vessel have received special consideration. A special feature is the ventilation of every compartment, both by natural and artificial means.

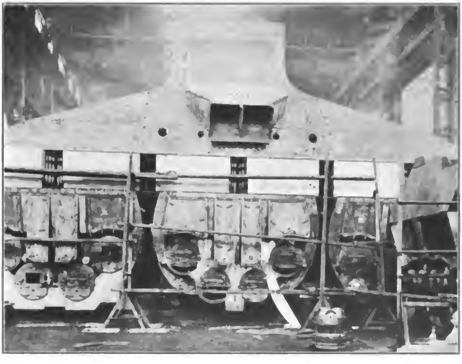
A complete installation of steam heating is fitted throughout

THE AMERICO-ITALIAN STEAMSHIP ANCONA ON TRIAL.

THE AMERICO-ITALIAN EMIGRANT STEAMER ANCONA.

BY BENJAMIN TAYLOR.

Early in January, Workman, Clark & Company, Ltd., launched from their north shipyard, Belfast, the first of two steamers built by them for the Italia Steam Navigation Company, of Genoa. As the vessel left the ways, she was named *Ancona*. The new ship is 500 feet in length, has a gross tonnage of 8,900, and has been specially designed for passenger service between Genoa, Naples, and New York. She has been built under the special survey of Lloyd's and the Registro Italiano for the highest class in their registers, and also fulfils all requirements of the Italian mercantile marine, and of



THREE FOUR-FURNACE BOILERS AND UPTAKES, ITALIAN EMIGRANT STEAMER ANCONA.

HOISTING ABOARD THE RUDDER QUADRANT AND A SECTION OF FUNNEL. STEAMER ANCONA.

the first class accommodation, captain's, officers', and crew's quarters. A large space has been set apart on the lower and orlop decks aft for the storing and preservation of fresh meat, fish, butter, eggs, and milk, and there is an efficient installation of refrigerating machinery.

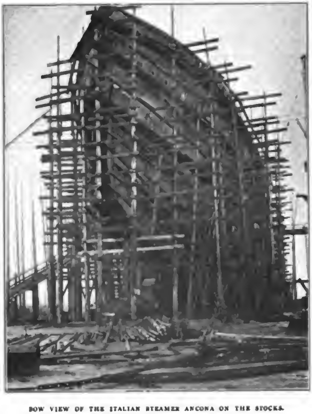
The propelling machinery consists of two three-crank triple-expansion engines, driving twin screws. The cylinders are 26, 43 and 71 inches in diameter, respectively, and the stroke is 4 feet. Internal liners are fitted to both the high-pressure and the intermediate-pressure cylinders; and the valves for controlling the steam and exhaust to and from these cylinders are of the piston type, with adjustable packing rings. The low-pressure cylinders are fitted with double-ported slide valves and improved balance pistons. All the hand gear for controlling and starting the engines is conveniently grouped, and arranged so as to be manipulated from the starting platform. Direct-acting engines of the steam and hydraulic type are provided for reversing the main engines, which develop 7,500 horsepower.

The condensers are built independent of the main engines, and contain an exceptionally large cooling surface, to deal efficiently with the exhaust steam passing from all the machinery when trading in tropical climates. Two large centrifugal pumps, by the builders, are provided for circulating the necessary cooling water through the condensers. Edwards' patent air pumps, with the necessary feed, bilge, and sanitary pumps, are worked by levers and links off the main engines, the two latter pumps being of specially large capacity. The propellers are of the built-up type, and are fitted with blades of manganese bronze.

The feeding of the main and auxiliary boilers is effected by two of Weir's patent automatic feed pumps, working in conjunction with a large feed-water heater of the same make. All the feed water, in passing to the boilers, is properly filtered. Independent pumps of Weir's make are provided for the special duties and requirements of the ship, including a large ballast pump, a fresh water pump, an auxiliary feed pump, besides separate pumps for the sanitary, wash-deck, fire, and other services.

The machinery for supplying electric current for lighting the vessel, and for other motive purposes, consists of three sets of vertical compound engines and dynamos of large capacity, the engines being direct-coupled to the dynamos. In connection with the insulated spaces for provisions, etc., a large refrigerating plant is fitted up in the main engine room, supplied by J. & E. Hall, London, and worked on the CO_2 principle. All the auxiliary plant is arranged in the main engine room, with the exception of the electric installation, which is arranged in a separate compartment on the lower deck, and is easily accessible from the engine room.

There are three large double-ended main boilers, and two auxiliary boilers, all arranged to work at a pressure of 200 pounds per square inch. Each of the main boilers has eight furnaces, provision being made to supply air under pressure on Howden's forced draft system. Two large fans are arranged in a suitable recess in the cross bunker for this purpose. The stokeholds are well ventilated, and are fitted with all the latest appliances for expeditiously discharging the ashes overboard.



BOW VIEW OF THE ITALIAN STEAMER ANCONA ON THE STOCKS.

Special tramway lines and tipping bogies are also provided, for rapidly conveying the coal from the bunkers, for firing purposes.

The five holds, into which the cargo space is divided, are spacious and free from obstruction, the hatches are large and easily accessible, the winches are numerous and powerful, and the derricks, swung from the masts and derrick posts, are plentiful, thus making it possible to handle a full cargo in the shortest possible time, and with the least amount of labor. The life boats are handled by Welin quadrant davits.

THE ANCONA ALONGSIDE CRANES FOR INSTALLATION OF BOILERS AND FUNNEL.

MARINE ENGINE DESIGN.*

BY EDWARD M. BRAGG, S. B.

The object of any heat engine is to reduce the temperature of the working fluid, this reduction of temperature being caused by the conversion of potential energy into work. In some respects the working fluid may be likened to a certain weight of water falling through a certain height. A turbine may be placed at the foot of the fall, and all of the energy of the water converted into work in one stage. A second turbine may be used half way down the fall, and the tail water from this turbine used to run the turbine at the foot of the fall; thus converting the potential energy of the water into work in two stages. In the same way, the conversion of potential energy into work may be divided into three, four, or more stages. In the heat engine, the range of temperature through which the working fluid can fall is similar to the head of water; and this range of temperature may be divided into two, three or four stages, as may seem best. When so divided, we have compound, triple, and quadruple-expansion engines. These terms apply to the number of stages employed—not to the number of cylinders.

While, in the steam engine, the reduction of temperature of the steam used is the object striven for, yet we are accustomed to deal with the temperature only indirectly. If the steam is saturated, a given temperature of steam will be accompanied by a certain pressure, so that when we reduce the pressure of the steam as low as possible, we are also reducing the temperature. In many ways it is more convenient to deal with the pressure of the steam, but the connection between pressure and temperature should not be forgotten.

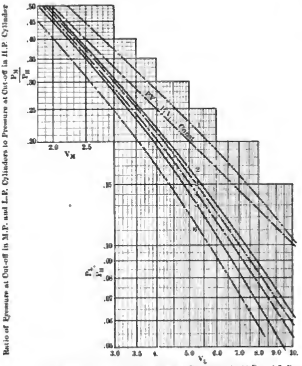
A reduction in the pressure of a gas may be obtained by causing it to occupy a larger volume, and while saturated steam is not a perfect gas, yet we can reduce its pressure by causing it to occupy successively larger volumes. The steam, in expanding, will exert against the piston of the cylinder in which the expansion is effected a constantly decreasing pressure, and this pressure can be used for doing external work. If the pressure against the piston were constant, the work done would be the product of the total pressure upon the piston and the distance through which it travels; but as the pressure is constantly decreasing, we must obtain in some way the average or mean pressure acting, and multiply that by the distance moved, the result being work done over that distance.

If the relation between pressure and volume is one that can be expressed mathematically, such as, for instance, $P_1V_1 = PV$, we can obtain the average pressure quite easily; but, unfortunately, the relation between the pressure of the steam and the volume occupied by it as it passes through the engine cannot be expressed in any such simple way. In Fig. 1 are shown some curves giving the relation between steam pressures and volumes, obtained from the indicator cards of numerous engines. The volumes used are the total volumes in the cylinders up to cut-off, including clearance, and the pressures are the absolute pressures at cut-off. It can easily be seen that no two engines would necessarily give the same curve of relation of pressures and volumes.

Suppose that we have two engines with high-pressure cylinders of the same size, taking steam at the same pressure, and the same pressure and volume in each at cut-off. Suppose that the same work is done in each, and the mean back pressures are the same in each. The pressures at cut-off in the next, or medium-pressure, cylinders will depend upon what happens to the steam in passing from one cylinder to the other. If the relative location of cylinders is different, so that the steam has to pass through longer pipes in one case than in the other; if the steam speeds used are different; if one pipe is better protected from radiation than the other;—the pressures at cut-off will be different in the next cylinders; so we cannot obtain any one curve that will give the relation between pressure and volume for all engines.

The curves 2, 3, 4 and 5, given in Fig. 1, are for the type of engine usual upon the ships of the merchant marine. The engine of a pumping plant, where every effort is made to get an economical engine by using jackets, reheaters, etc., will give a curve like 1; while the engine of a naval vessel may lie in the region of curve 6. These curves give the relation between pressure and volume ratios; the unit pressure and volume being that at cut-off in the high-pressure cylinder. In using such as curve for engine design it is best, wherever possible, to derive the curve from an engine similar to the one

* For the sake of simplicity the title of this article is MARINE ENGINE DESIGN, but it is desired to direct attention as well to the desirability of systematic data-keeping. Whenever possible, coefficients and factors of safety should be determined from data of similar engines working under as nearly as possible the same conditions. In this way only can it be claimed for an engine that it is *designed* for its work. Only the main points of marine engine design will be taken up, but the proportions of other parts can be determined in a similar manner.



Ratio of Vol's. at Cut-off (including Clearance) in M.P. and L.P. Cylinders to Vol. at Cut-off in H.P. Cylinder

FIG. 1.

projected, but if no such data are at hand, a curve can be chosen from the region of curves 2, 3, 4 and 5, in Fig. 1. Curve 3 is for a quadruple expansion engine in which the steam speeds varied from 7,000 to 11,000 feet per minute. Curve 4 is for a naval engine, whose data are given in Cards I. and II. The steam speeds here varied from 8,000 to 13,000 feet per minute. The more efficient engines with the lower steam speeds will probably lie in the neighborhood of curves 2 and 3, while higher steam speeds and a lower efficiency will cause them to lie in the neighborhood of curves 4 and 5. The way in which such curves can be used for purposes of design will be explained later on.

CYLINDER DIMENSIONS.

There are certain data which must be available before a start can be made upon the design of any engine. It is usual to give the desired indicated horsepower, the boiler pressure, the piston speed and the number of expansions. The piston speeds for engines of the merchant marine usually range from 600 feet per minute to 1,000 feet per minute. The higher the piston speed the more attention the engine will require; the greater will be the bill for repairs, and the shorter will be the engine's life. The number of expansions to be used for a given boiler pressure will be determined by experience, and will be a compromise between the number which will give the greatest economy and that which will give the engine of least weight.

The formula for indicated horsepower is

$$I.H.P. = \frac{2plan}{33{,}000}, \qquad (1)$$

where p is the mean unit pressure acting upon an area a, through a distance of $2ln$, or the piston speed; l is the length of stroke in feet, and n is the revolutions per minute. Referring to the data supposed to be available, it will be seen that the unknowns are

$$pa = \frac{I.\ H.\ P. \times 33{,}000}{\text{piston speed}} \qquad (2)$$

As stated before, work is derived from the steam by reducing its temperature by means of expansion; the increase in volume and decrease in temperature being accompanied by a decrease in pressure. The actual rate at which the pressure decreases cannot be stated in any simple form, but it is usual and convenient to assume the relation between pressure and volume to be given by the formula $P_1 V_1 = PV =$ constant; the character of the curve being that shown in Figs. 1 and 2. The deviation of the actual rate from the assumed rate, and certain losses, are allowed for by using a design factor derived from engines in use. The design factor F for the engine whose data are given in Cards I. and II., is 0.577, and is obtained by dividing the area inclosed in the dotted lines of Fig. 2 by the area $aturx$.

The mean pressure exerted upon an unit area while the steam is expanding from an initial pressure P_1 and volume at, to the volume wv, will be given by the formula

$$MP = P_1 \frac{(1 + \log_e R)}{R}, \qquad (3)$$

where R is the number of expansions

$$\frac{wv}{at} = \frac{\text{final volume}}{\text{initial volume}}.$$

The proof of this can be found in any book on thermodynamics. The theoretical mean effective pressure will be

$$T.M.E.P. = P_1 \frac{(1 + \log_e R)}{R} - P_b, \qquad (4)$$

and the actual mean effective pressure to be expected in the engine will be

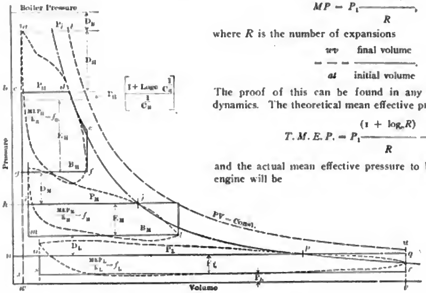


FIG. 2.

$$MEP = \left[P_1 \frac{(1 + \log_e R)}{R} - P_b \right] F. \qquad (5)$$

This *MEP* in (5) will be the *p* of (2), so that the value of the only remaining unknown *a* can be found. This *a* will be the area of the cylinder of the single-stage expansion engine, or the area of the low-pressure cylinder of any engine where the expansion or reduction of temperature is effected in more than one stage. In order to see this, it is only necessary to remember that in order to produce the desired indicated horsepower, starting with steam of a given pressure and expanding it a certain number of times, a certain weight or volume of steam will have to be used. After this steam has been expanded the chosen number of times, it will occupy a definite volume, irrespective of the number of stages of expansion, and that final volume will be the volume of the low-pressure cylinder. Therefore,

$$LP = a = \frac{I.\ H.\ P. \times 33{,}000}{P.\ S. \times MEP}. \qquad (6)$$

A low-pressure cylinder having been provided, of sufficient capacity to allow for the desired expansion of the weight of steam necessary to produce the desired indicated horsepower, the next step is to provide a cylinder of sufficient size to take in the necessary amount of steam from the boiler. As it is desirable that some portion of the total expansion should take place in this cylinder, it will not take steam from the boiler during its full stroke, but will cut off communication at some fraction of the stroke. The number of expansions

$$R = \frac{\text{final volume of steam}}{\text{initial volume of steam}} = \frac{\text{area of L. P. cyl.} \times \text{stroke}}{\text{area of H. P. cyl.} \times \text{stroke} \times \text{fraction of cut-off}} = \frac{LP}{HP \times C_h}.$$

Therefore,

$$HP = \frac{LP}{R \times C_h}. \qquad (7)$$

If the expansion takes place in one cylinder, or in a single-stage engine, then

$$HP = LP, \text{ and } C_h = \frac{LP}{HP \times R} = \frac{1}{R};$$

and the cut-off fraction will be the reciprocal of the number of expansions.

Between the high-pressure cylinder and the low-pressure cylinder we can put as many cylinders as is thought advisable. The number will not affect materially the total power developed, but will merely divide the expansion into as many stages as is necessary for economical use of the steam. The sizes of these intermediate cylinders, and the cut-offs in all cylinders except the high-pressure cylinder, will affect only the distribution of work among the cylinders.

The reason for using two or more stages for the expansion of the steam is to avoid the loss by initial condensation that occurs when the range of temperature in one cylinder is more than 75 or 80 degrees F. In a double-acting engine, at the beginning of the stroke, there is upon one side of the piston, steam at the temperature of the source of supply, and on the other, steam at the temperature of exhaust. As the piston moves, the high-temperature steam comes in contact with a portion of the cylinder wall which just previously has been in contact with the low-temperature steam, and condensation results. It is to reduce this difference of temperature, and the consequent condensation, that the range of temperature in one cylinder is limited by dividing the total expansion into two or more stages. Thus the number of stages will depend upon the total range of temperature, or upon the initial pressure of the steam to be used. In Table I. are shown the values of the different quantities for merchant engines and naval engines.

TABLE I.

Type.	Initial Pressure at Engine, Absolute. P	Nominal Expansions. R	High-pressure Cutoff. C_h	Back Pressure in Low-pressure Cylinder. P_b	Design Factor. F
Triple naval	185 to 200	6 to 8½	0.70 to 0.80	5 to 7	0.58 to 0.70
Triple merchant	165 to 185	9 to 12	0.65 to 0.75	5 to 6	0.65 to 0.75
Quadruple merchant	190 to 210	12 to 14	0.65 to 0.75	5 to 6	0.55 to 0.70

Collecting together the principal formulæ used so far, we have:

$$MEP = \left[P_1 \frac{(1 + \log_e R)}{R} - P_b \right] F \qquad (5)$$

$$\text{Area of } LP = \frac{I.\ H.\ P. \times 33{,}000}{PS \times MEP} \qquad (6)$$

CARD I.

Name of Ship.	H.P.		1 M.P.		2 M.P.		L.P.	
Size of engine $\frac{27-41-64}{30}$	top	bot.	top	bot.	top	bot.	top	bot.
Cutoff—Designed or apparent,	.77	.71	.78	.68			.75	.69
Cutoff—Mean,	.74		.73				.72	
Clearances.								
Clearances—Mean of top and bottom,	.134		.10				.089	
Initial pressure—Absolute,	163	163	78	76			27	29
Cutoff pressure—Absolute,	123	127	49	54			17½	19½
Cutoff pressure—Mean absolute,	125		51.5				18.5	
Average back pressure—absolute,	73		31				6.5	
Effective cutoff pressure,			20.5				12.0	
M. E. P. from indicator cards,	53.5	59.2	23.5	25.4			14.0	13.4
Mean of top and bottom, M. E. P.,	56.4		24.4				13.7	
I. H. P. developed in cyl. P. S. = 838	824		820				1115	
M. E. P. when power is equally distrib.,	63.3		27.4				11.26	

$$\text{Area of } HP = \frac{LP}{R \times C_h} \qquad (7)$$

The stroke has usually some one of the following values: 18, 21, 24, 27, 30, 33, 36, 39, 42, 45, 48, 54, 60, 66, or 72 inches. The ordinary merchant engine will have one of the above values of stroke, nearest the square root of the product of the diameters of the high-pressure and low-pressure cylinders. In naval engines the stroke will be less than this, in extreme cases being only 50 percent of the above value. On the other hand, in slow-running, economical freight steamer engines, it will be greater by 10 to 15 percent.

The proper diameter for the intermediate-pressure cylinder or cylinders, and the cut-off in the mean-pressure and low-pressure cylinders, will be chosen to give a good distribution of work among the cylinders. In order to make this choice with intelligence, the data obtained from engines in service should be worked up in such a way as to be readily used. A system of data keeping which has been found to give good results deals with the following quantities and relations: The curve of relation between cut-off pressures and total volumes

at cut-off in the different cylinders (see curve djp, Fig. 2); the drop D_h from the initial pressure to the cut-off pressure in the high-pressure cylinder; the mean back pressure in each cylinder, B_h, B_m, P_b; the drop from the mean back pressure of one cylinder to the cut-off pressure of the next succeeding, D_m and D_l; the relation between the mean effective pressure of the high-pressure indicator card MEP_h and the mean effective pressure E_h of a card $cdefg$, which assumes that the steam enters at the cut-off pressure and expands with $PV =$ constant,

$$\frac{MEP_h}{E_h} = f_h;$$

the relation between the MEP of the mean-pressure and low-pressure cylinder indicator cards and the effective cut-off pressures in those cylinders,

$$\frac{MEP_m}{E_m} = f_m, \quad \frac{MEP_l}{E_l} = f_l.$$

This data can be kept on a card similar to that shown in Card I., and when worked up, as shown in Card II. on the back of the card, the necessary factors and relations will be available.

There are various ways of getting the design factor F. In this system of data keeping the engine is not charged with the loss of pressure that occurs between the boiler and the engine,

CARD II.

$$\text{No. of expansions} = \left(\frac{64}{27}\right)^2 \frac{1}{0.74} = 7.61$$

$$163\frac{3.0295}{7.61} - 6.5 = 65 - 6.5 = 58.5$$

$$56.4\left(\frac{27}{64}\right)^2 = 10.05$$

$$24.4\left(\frac{41}{64}\right)^2 = 10.02$$

$$\frac{13.7}{33.77}$$

$$\frac{33.77}{58.5} = 0.577 = \text{Design factor } F.$$

$$D_h = 163 - 125 = 38$$
$$D_m = 73 - 51.5 = 21.5$$
$$D_l = 31 - 18.5 = 12.5$$
$$\overline{72.0} = D$$

$$\frac{72}{163} = 0.442$$

$$125\frac{1 + 0.3001}{1.35} = 120$$
$$\frac{73}{47}$$

$$\frac{56.4}{47} = 1.20 = f_h$$

$$\frac{24.4}{20.5} = 1.19 = f_m$$

$$\frac{13.7}{12} = 1.14 = f_l$$

For power equally distributed

$$\frac{33.77}{3}\left(\frac{64}{27}\right)^2 = 63.3 \quad \frac{63.3}{47 + 6.9} = 1.17 = f_h$$
$$\frac{56.4}{6.9}$$

$$\frac{33.77}{3} \times \left(\frac{64}{41}\right)^2 = 27.4 \quad \frac{27.4}{20.5 + 3} = 1.165 = f_m$$
$$\frac{24.4}{3.}$$

$$11.26 - 13.7 = -2.4$$

$$\frac{11.26}{12 - 2.4} = 1.172 = f_l$$

$$\frac{51.5}{125.} = 0.412 = P_m \quad \frac{18.5}{125.} = 0.148 = P_l$$

$$\frac{(41)^2 \times (0.73 + 0.10)}{(27)^2 \times (0.74 + 0.134)} = 2.19 = V_m$$

$$\frac{(64)^2 \times (0.72 + 0.069)}{(27)^2 \times (0.74 + 0.134)} = 5.07 = V_l$$

as this will vary with the relative location of engine and boilers, steam speeds used and general layout of piping. The values given for F, in Table I., consider the steam as entering the engine with the initial pressure shown on the high-pressure indicator card, expanding the nominal number of times with $P_1V_1 = PV =$ constant, and with a back pressure equal to the mean back pressure of the low-pressure cylinder indicator card. The nominal number of expansions does not take into consideration the reduction of expansion due to clearances.

The design factor F takes account not only of the deviation of the actual relation of pressure and volume from the assumed, but also of the losses of pressure that occur while the steam is passing from one cylinder to the next. We should expect, therefore, that the sum of the drop $D = D_h + D_m + D_l$ would depend upon the value of the design factor. It has been found that there is such a relation, and the approximate values of D are given in connection with F, as a portion of the absolute initial pressure P_1.

TABLE II.

$F =$	0.6	0.65	0.675	0.70	0.725	0.75	0.80
$\frac{D}{P_1} =$	.35—.40	.25—.29	.235—.27	.225—.25	.21—.23	.20—.215	.175—.185

$D_h = 0.5$ to $0.6D$; $D_m = 0.25$ to $0.35D$; $D_l = 0.12$ to $0.17D$

The drop D_b from boiler to engine will vary from 10 to 25 pounds, usually being from 15 to 20 pounds. The relative values of D_h, D_m and D_l will not be constant, as can be easily seen when the causes of the drop are considered. No two engines will necessarily work under the same conditions, so that the relative values can be only approximately indicated. Whenever possible, the various factors, drops, etc., should be derived from engines similar to the one projected, working under like conditions.

The card factors f_h, f_m and f_l should be reduced to some standard condition. The character of the admission line and back pressure line of an indicator card will not change essentially if there is 10 percent more or 10 percent less work developed in the cylinder. The two lines will be bodily separated or brought closer together. The standard condition chosen in the case of the triple engine is that which exists when one-third of the total indicated horsepower is developed in each cylinder. Thus, if the MEP of an indicator card is 31, and the effective cut-off pressure is 28, while the MEP should be 33 in order that one-third of the work may be done in that cylinder, the corrected value of f_m is

$$\frac{31 + 2}{28 + 2} = 1.1.$$

It can be seen by referring to Fig. 2 that f_h will vary with the drop D_h, and f_m and f_l will vary with the fraction of cut-off in the cylinder. It was found that the values of f_h, f_m and f_l, when reduced to the standard condition, could be given by the formulæ,

$$f_h = 1 + \frac{D_h - 16}{100} \qquad (8)$$

$$f_m = 2.25\,C_m - 0.475 \qquad (9)$$

$$f_l = 1.25\,C_l + 0.256 \qquad (10)$$

where D_h is the drop from initial to cut-off pressure, and C_m and C_l are the fractional cut-offs in the mean-pressure and low-pressure cylinders. The way in which these factors and relations of pressure and volume can be used for design purposes can be best shown by means of an example:

$I.\ H.\ P. = 3{,}000$; $P.\ S. =$ piston speed $= 850$ feet per minute; boiler pressure $= 185$ pounds gage; $P_b =$ back pressure in low-pressure cylinder $= 5.5$ pounds; $R =$ number of expansions $= 11$; $C_h =$ cut-off in high-pressure cylinder $= 0.675$; $F =$ design factor $= 0.7$. Work to be equally divided among the three cylinders.

The initial pressure at the engine will be taken as 170 pounds gage, or 185 pounds absolute, allowing a drop of 15 pounds from the boiler to the engine. Table II. gives the allowable total drop for a design factor of 0.7 as 0.225 to 0.25 of P_1. We will use $D = 0.24\ P_1 = 0.24 \times 185 = 44.5$ pounds.

$$D_h = 44.5 \times 0.55 = 24.5; \quad D_m = 44.5 \times 0.30 = 13.5;$$
$$D_l = 44.5 \times 0.15 = 6.5$$

From (5) $$MEP = \left[185\frac{1 + 2.398}{11} - 5.5\right] \times 0.7$$
$$[= 57.1 - 5.5\,] \times 0.7 = 36.1$$

From (6) $$LP = \frac{3{,}000 \times 33{,}000}{850 \times 36.1} = 3{,}230 \text{ square inches; diameter} = 64 \text{ inches.}$$

From (7) $HP = \dfrac{3,230}{11 \times 0.675} = 435$ square inches; diameter $= 23\frac{1}{2}$ inches.

$\sqrt{64 \times 23\frac{1}{2}} = 38.8$. Let stroke $= 42$ inches.

In order that one-third of the total work may be done in the high-pressure cylinder, the *MEP* of the indicator card must be

$$MEP_h = \frac{36.1}{3} \times \left[\frac{64}{23.5}\right]^2 = 89 \text{ pounds.}$$

From (8) $f_h = 1 + \dfrac{24.5 - 16}{100} = 1.085$; $E_h = \dfrac{89}{1.085} = 82$ pounds

$P_h = 185 - 24.5 = 160.5$ pounds.

$$B_h = P_h \frac{1 + \log_e \dfrac{1}{C_h}}{\dfrac{1}{C_h}} - E_h = 160.5 \times \frac{1 + 0.392}{1.48} - 82 = 152 - 82 = 70$$

$P_m = B_h - D_m = 70 - 13.5 = 56.5$ pounds.

$$\frac{P_m}{P_h} = \frac{56.5}{160.5} = 0.352.$$

The volume ratio that will give this pressure ratio, 0.352, will be found by using curve 3 in Fig. 1. The volume ratio $V_m = 2.63$. These values of P_m and V_m will be used later. Having found P_m, we will now proceed to get B_m by working up from the low-pressure cylinder.

We have assumed that curve 3, Fig. 1, gives the relation between pressure ratios and volume ratios for the engine we are designing, so that when we assume a certain cut-off in the low-pressure cylinder the cut-off pressure is determined from the curve. This cut-off pressure must be sufficient to give an effective cut-off pressure E_l, of such a value as will insure that one-third of the work is done in that cylinder. The relation between E_l and MEP_l will be given by (10).

In order to get the volumes up to cut-off, we must know the clearances. It will be best to determine these by comparison with a similar engine, but if no such data are at hand the following clearances can be assumed for merchant ship engines, where the stroke $= \sqrt{\text{high-pressure diam.} \times \text{low-pressure diam.}}$:

High-pressure cylinder	0.17 to 0.20.
Medium-pressure cylinder	0.13 (piston valves); 0.11 (slide valves)
Low-pressure cylinder	0.12 (piston valves); 0.09 (slide valves).

These values will increase as the stroke gets relatively shorter, so that they should be mutiplied by

$$\sqrt{\frac{\text{High-pressure diameter} \times \text{low-pressure diameter}}{\text{stroke}}}$$

to get the approximate clearances in other cases.

We will take the clearances as $Ch = 0.17$, $Cl_m = 0.13$, $Cl_l = 0.12$ for the high-pressure, mean-pressure and low-pressure cylinders, respectively.

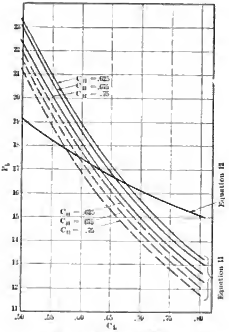
The value of P_l can be obtained from curve 3, Fig. 1, as follows: The volume ratio will be

$$V_l = \frac{(C_l + Cl_l)LP \times s}{(C_h + Cl_h)HP \times s} \qquad (11)$$

With this value of V_l the value of P_l/P_h can be obtained from the curve, and knowing P_h, the value of P_l is known. The value P_l must also be such as will cause the necessary work to be done in the cylinder, or,

$$P_l = P_b + \frac{MEP_l}{1.25C_l + 0.256} \qquad (12)$$

In order to find the value of P_l which will satisfy both equations (11) and (12), we will assume values of C_l, plot the resulting values of P_l on C_l, and find where the two curves cross.



Full Lines from Curve 3, Fig. 1.
Broken " " " 4, Fig. 1.

FIG. 3.

From (11) $V_l = \dfrac{(C_l + 0.12)3,230}{(0.675 + 0.17)435} = (C_l + 0.12) \times 8.8$

From (12) $P = 5.5 + \dfrac{12.63}{1.25\,C_l + 0.256}$

TABLE III.

C_l	V_l	From Fig. 1. P_l/P_h	P
0.5	5.45	0.144	23.1
0.6	6.33	0.116	18.6
0.7	7.22	0.096	15.4
0.8	8.08	0.082	13.2

C_l	P_l
0.5	19.17
0.6	17.46
0.7	16.17
0.8	15.1

When these values are plotted upon C_l as abscissæ, the resulting curves cross at a pressure of 16.65 pounds, and with $C_l = 0.655$ (see Fig. 3). $C_h = 0.675$.

$$B_m = P_l + D_l = 16.65 + 6.5 = 23.15$$

The value of $P_m = 56.5$ has been previously obtained.

$$E_m = P_m - B_m = 56.5 - 23.15 = 33.35$$

We are now ready to determine the mean-pressure diameter and cut-off. Here again there are two conditions which must be fulfilled, and consequently two equations to use. The value of E_m, when multiplied by the factor f_m, depending upon the cut-off, must give a MEP_m that will do the necessary work when acting upon the mean-pressure cylinder area. This gives the equation:

$$E_m \times f_m = MEP_m = \frac{MEP \times LP}{3 \times MP} = E_m(2.25C_m - 0.475)$$

$$MP = \frac{MEP \times LP}{3E_m(2.25C_m - 0.475)}. \qquad (13)$$

or

This area of mean-pressure cylinder and cut-off must also be such as will give the proper volume ratio V_m previously obtained from the pressure ratio P_m/P_h.

$$\frac{MP(C_m + Cl_m) \times s}{HP(C_h + Cl_h) \times s} = V_m$$

or,

$$MP = \frac{V_m \times HP(C_h + Cl_h)}{C_m + Cl_m} \qquad (14)$$

We can equate (14) and (13) and solve for C_m, the only unknown.

Let $X = V_m \times HP(C_h + Cl_h)3E_m$, and
$Y = MEP \times LP$.

Then,

$$CM = \frac{0.475X + Cl_mY}{2.25X - Y}.$$

This value of C_m, substituted in either (13) or (14), will give the area of the mean-pressure cylinder. For the engine we are designing

$$X = 2.63 \times 435(0.675 + 0.17) \times 3 \times 33.35 = 96{,}200.$$

$$Y = 36.1 \times 3{,}230 = 116{,}700.$$

$$C_m = \frac{0.475 \times 96{,}200 + 0.13 \times 116{,}700}{2.25 \times 96{,}200 - 116{,}700}$$

$$= \frac{45{,}700 + 15{,}150}{217{,}000 - 116{,}700} = \frac{60{,}050}{101{,}300} = 0.60$$

$$MP = \frac{2.63 \times 435(0.675 + 0.17)}{0.60 + 0.13} = 1{,}328, \text{ diameter} = 41 \text{ inches.}$$

Collecting together the quantities calculated and assumed so far, we have

	High-Pressure.	Medium-Pressure.	Low-Pressure.
Diameter in inches.........	23½	41	64
Cut-off....................	0.675	0.60	0.655
Clearance..................	0.17	0.13	0.12
Stroke, inches.............	42	42	42

If the high-pressure cut-off had been taken as 0.625, the results would have come as follows (see Fig. 3, full line curve, $C_h = 0.625$):

	High-Pressure.	Medium-Pressure.	Low-Pressure.
Diameter in Inches.........	24½	42	64
Cut-off....................	0.625	0.56	0.67

If the high-pressure cut-off had been taken as 0.75, the following results would have been obtained (see Fig. 3, full line curve, $C_h = 0.75$):

	High-Pressure.	Medium-Pressure.	Low-Pressure.
Diameter in inches.........	22½	39½	64
Cut-off....................	0.75	0.71	0.635

In computing the foregoing results, curve 3 in Fig. 1 was used. If curve 4 had been used, the results would have been as follows (see Fig. 3, broken curves):

	High-Pressure.	Medium-Pressure.	Low-Pressure.
Diameter in inches.........	23½	39	64
Cut-off....................	0.675	0.655	0.595
Diameter in inches.........	24½	40	64
Cut-off....................	0.625	0.61	0.615
Diameter in inches.........	22½	36¾	64
Cut-off....................	0.75	0.81	0.575

It may not be thought advisable to use any one of the sets of results as it stands. The effect of any change, however, can be foreseen, as an increase of the cut-off in any cylinder will cause less power to be developed there and more power in the preceding cylinder. A shortening of the cut-off will have the reverse effect. It will be noticed that an increase of the high-pressure cut-off is accompanied by an increase of the mean-pressure cut-off, and a decrease of the low-pressure cut-off if equal powers are to be developed in each cylinder; while a decrease in the high-pressure cut-off causes the mean pressure to decrease and the low pressure to increase.

(To be Continued.)

PRACTICAL EXPERIENCE WITH MARINE STEAM TURBINES.

Built, building, or on order, there are now some 140 vessels fitted with marine turbines, mostly of the Parsons type. Signs, however, are not lacking that other systems will soon be acknowledged competitors, the sound, practical features of the impulse type of machine giving it many advantages. Some of these vessels have now been in service for several years, and information is rapidly accumulating with regard to the once uncertain questions of durability, operation and cost of maintenance. So much has been written and said, on short acquaintance, of the virtues of marine turbines that their defects are seldom heard of, but experience proves that the annual overhaul of the machinery occasionally involves a good deal of work. In many cases, however, the difficulties involved have led to improved design of the details affected, or to more careful methods of operation.

One of the most prolific causes of trouble is the use of dirty feed-water. Elaborate strainers are fitted on each steam pipe to the main turbines to catch any solid matter coming over from the boilers, but the finer particles get through and frequently choke up the passages between the smaller rows of blades. The result is that a higher steam pressure (which is not always available) is necessary to maintain the same speed, and the trouble of removing the scale formed on the blades is considerable. This deposit is frequently found on the inlet blades of the low-pressure turbines, the surfaces of which become coated like the inside of a kettle. As long as this hard scale adheres to the blades its presence is detrimental only to economy, but in the event of pieces becoming detached, "blade stripping"—with which we propose to deal at length in a later issue— is extremely likely to occur. On the other hand, should the grit, caused by the disintegration of the scale, get into the "dummy packing," which depends on very fine clearances, the brass strips are likely to be badly worn, thereby increasing the clearances and the leakage loss.

Another effect of dirty feed-water is to induce priming, and while it is doubtful whether small quantities of water are sufficient to cause blade stripping, severe stresses on the blading are set up if much priming occurs. On their early voyages, both the *Victorian* and the *Virginian* seem to have suffered from this, and the effect of excessive scale has been noted on several of the channel steamers, as well as in large land installations. The warships belonging to the royal navy do not seem to be troubled, but in their case great care is taken to use only clean feed-water, and attention should always be paid to this point in turbine vessels.

It has been found that the main bearings, which in reciprocating engines constantly require attention, give practically no trouble whatever for months together, provided that the lubrication system is kept in good order. The pressure being low—generally only about 30 pounds per square inch—and the direction of rotation and pressure practically constant, the wear observed after twelve months' running is practically nil, and cases can be cited of marine turbine bearings that have run for over three years without adjustment.

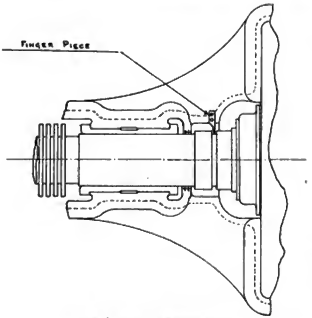


FIG. 1.—PLAN OF TURBINE BEARING.

The same applies to thrust blocks, in the case of which little attention is necessary when the turbine is at work. They perform the function, however, of an adjusting block as well, for the main turbines, and the rotor is set for dummy clearance by their means. This adjustment is a somewhat "ticklish" job. The rotor is so designed that the pressure, due to the steam acting on the blades, is rather greater than that due to the propeller; hence any wear that takes place in the thrust collars does so in the direction of the main steam flow; the rotor consequently tends to recede from the dummies. A groove in the shaft between the bearing and the gland, and a finger-piece set in a definite position on the cylinder and projecting into the groove, as shown in Fig. 1, provide a ready means of determining the amount of wear. At convenient intervals the shafting is disconnected aft of the rotor, and the latter is drawn up to the prescribed clearance again by means of the adjusting block screws. The wear, however, is so slight, that, as a rule, this adjustment requires to be made only once or twice a year.

Another feature that needed modification in a great many of the earlier vessels was the astern dummy ring. On account of the longitudinal expansion of the rotor, these dummy rings had to be made radial; they were placed on an extension of the astern turbine drum, which, having to carry only these rings, was made very thin. In numerous cases this drum became bell-mouthed when running, owing to centrifugal force, thereby wearing off the dummy rings and causing excessive leakage when running astern. This early design is shown in

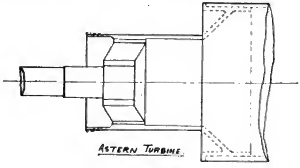


FIG. 2.

Fig. 2, while Fig. 3 gives the stiffer modern type now adopted with success. Fig. 4 shows the arrangement of astern dummy rings.

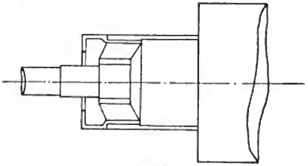


FIG. 3.

An utterly unsuspected source of considerable trouble in marine turbine plants has been found to lie in leaky condenser tubes, causing corrosion of the rotor drums of the low-pressure turbines. In some cases this phenomenon has proved extremely serious. Generally speaking, turbines run so satisfactorily in service that the covers seldom need to be lifted, and many cases can be quoted of vessels requiring this attention only once a year. Perhaps the best instance of this kind is the *Carmania*. Her turbines remained closed from the time they were put on board the ship until the completion of twelve months in service, and the ship has just now completed a second year's service, when they were lifted again. Such immunity involves trusting to luck, to some extent, as to the internal condition of the turbine. The pressure gages and tachometers show if any stripping or choking of the blades has occurred, but the out-of-balance that results from unequal corrosion is generally first put down to the propeller being damaged.

In the case of several cross channel steamers—particularly those running on the Great Western Railway Company's service between Fishguard and Rosslare—it was noticed that the rotors were out of balance, and at the annual overhaul abnormal corrosion was found to have attacked the insides of the low-pressure turbine drums, as well as all wrought iron

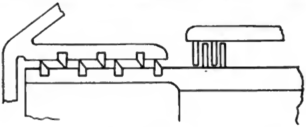


FIG. 4.

nuts inside the casing. This corrosion arises chiefly from salt water leaking back from defective condenser tubes through the non-return valves on the low-pressure drain pipes, and if neglected may prove very serious. The external portions of the rotor are not attacked, curiously enough, leading to the supposition that in addition to salt water, stagnant water that may have been unable to escape from the interior of the drum, owing to the choking up of the drainage grooves, has been whirled around and around inside, causing severe erosion.

A good deal of air probably leaks into the turbine through the glands. Those on the low-pressure turbines have to keep tight against atmosphere on one side and a high vacuum on the other, and in some cases, if the steam supply to the glands is not adjusted properly, a considerable amount of air may

get in. The water sealed gland so much preferred in American land turbine practice does not seem to be used in marine work. In any case, the prevention of salt water and air leakage into the turbine should go far to obviate any chance of corrosion. It is a defect that has not been found in well-kept engine rooms.

Glands often require a great deal of attention. In all the early turbine steamers they could be overhauled only by lifting cover and rotor, as they consisted of Ramsbottom rings fitted in grooves in the shaft. It was not for some years that Parsons adopted the external gland, which seemed so essential to convenience. These Ramsbottom rings wear very quickly sometimes, but this fact is easily noticed on account of the greatly increased flow of steam past them into the engine room. There is still considerable room for improvement in turbine glands; their essentials are shortness longitudinally, tightness without wear, and ease of adjustment, and these are not easy to arrive at.

Contrary to a popular idea, not only is vibration frequently met with on turbine steamers, but that vibration is sometimes excessive. The *Lusitania*, *Mauretania* and *Carmania* are by no means free from it, and some of the channel steamers are

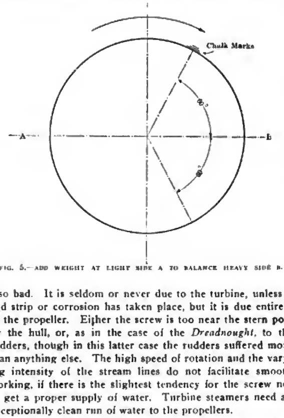


FIG. 5.—ADD WEIGHT AT LIGHT SIDE A TO BALANCE HEAVY SIDE B.

also bad. It is seldom or never due to the turbine, unless a bad strip or corrosion has taken place, but it is due entirely to the propeller. Either the screw is too near the stern post or the hull, or, as in the case of the *Dreadnought*, to the rudders, though in this latter case the rudders suffered more than anything else. The high speed of rotation and the varying intensity of the stream lines do not facilitate smooth working, if there is the slightest tendency for the screw not to get a proper supply of water. Turbine steamers need an exceptionally clean run of water to the propellers.

In balancing turbine rotors in the shop, two methods are generally used. First, the rotor is placed on knife edges and slowly moved, first one way and then the other, to determine the heavy side, if there is one. This can be corrected very accurately by this method, and it will generally be found best to cut off weight from the heavy side, rather than to add it to the light side. Very little is required to correct a rotor that is even badly out of balance, but with good workmanship the latter very seldom occurs. The second method is to run the rotor up to speed in the turbine under steam, and to determine the heavy side by chalking the shaft, which tends to revolve eccentrically. It should be noted, however, that the chalk marks on the shaft do not correspond exactly with the heavy side, but occur at a spot about 60 degrees behind it; this, of course, requires to be taken into account.

In the case of land turbine rotors, which are sometimes run up to speed in special bearings by means of an electric motor, it is easy to arrange to run the shaft, first in one direction and then in the other, so that a mean position can easily be found for the heavy side. The difficult case occurs, of course, when the rotor is out of balance at opposite sides at the two ends. When vibration in turbine steamers can be prevented to the extent that it has been in some vessels, it is annoying to find it so developed in some others. Care in design and workmanship is all that is needed to avoid it.

Great care must be taken that the oil remains in good condition. The consumption of this item is very small indeed, as it is used over and over again, the system, consisting of oil tank, cooler and pump, being a closed one. The temperature at which the turbine bearings work is generally between 90° F. and 120° F., depending rather on their position—for instance, the forward high-pressure bearing, which is very near the steam belt, is obviously hotter than the after low-pressure one. A cooler is essential, and the oil, after leaving the bearings, passes through a spiral coil, which is immersed in circulating water. This coil needs to be a good tight job, as cases have been known where water has leaked into the oil supply, with disastrous results. Ample cooling surface should be allowed.

Marine turbines seldom or never work with superheated steam, as is the case with land turbines. In the latter, the bearing temperatures are often very high cases up to 190° F. having been known to run without trouble. Special oils are necessary for such conditions, but for ordinary work "Valvoline" has been found to give excellent results. It is a great mistake to use too high an oil pressure—5 to 6 pounds per square inch is ample, and the supply should be maintained very regular. A gravity system, in which the oil supply is situated high up in the engine room hatch, is very useful; the pump is then used merely to force the oil through the coolers and up to the tank.

SPEED TRIALS AND SERVICE PERFORMANCE OF THE CUNARD TURBINE STEAMER LUSITANIA.*

BY THOMAS BELL.

It is with feelings of some diffidence that I place before the members of this institution a brief record of the trials and running in service of the Cunard turbine steamer *Lusitania*, for, apart altogether from the fact that the propelling machinery consists of Parsons turbines, the leading proportions of the design of the ship and machinery are the outcome of most careful deliberations on the part of the technical staff of the Cunard Company, of the turbine committee, of the Hon. C. A. Parsons and his assistants, of the Admiralty, of Lloyd's committee, and of the Board of Trade, in conjunction with the staff of the three firms intrusted with the design and construction of the two express Cunarders, so many of whom are distinguished members of this institution. Very full reports of the trials have been published in the technical press, but your council considered that the subject had not yet been exhausted, and it is hoped that this brief paper may furnish material for an interesting discussion on some points connected with this great Cunard enterprise.

As already described so fully in the technical and other journals, and as shown on accompanying diagrammatic plan, Fig. 1, the turbine machinery of the *Lusitania* consists of two pairs of compound turbines, a pair consisting of one high-pressure and one low-pressure unit, each of which actuates a line of shafting, so that there are four lines in all. The high-pressure turbines drive the wing shafts, and the low-pressure

* Read before the Institution of Naval Architects, April 9, 1908.

turbines the center shafts. At the forward end of the low-pressure turbines are placed the astern turbines. This particular arrangement, in which the two center propellers are used for maneuvering purposes, was forced on the designers by exigencies of space as the only possible one, and has proved most satisfactory.

The boilers, as will be seen from Fig. 2, are divided into four equal groups in separate watertight compartments. The coal bunkers are situated only at the sides in the three after boiler rooms, but in the forward boiler room, owing to the fineness of the ship, the capacity of the side bunkers is comparatively small, and a large athwartship bunker becomes necessary, in addition to those at the sides.

The following are the principal dimensions and particulars of the turbines, condensers, shafting and boilers:

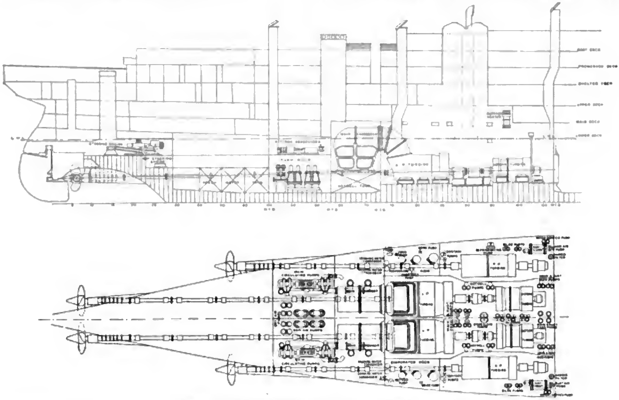


FIG. 1. ARRANGEMENT OF TURBINES AND SHAFTING, STEAMSHIP LUSITANIA.

Turbines.	Diameter of Rotor.	Length of Blades. In First Expansion.	Length of Blades. In Last Expansion.
High-pressure	96 inches	2½ inches	12 inches
Low-pressure	140 inches	8½ inches	22 inches
Astern	104 inches	2½ inches	8 inches

Total cooling surface, main condensers .... = 82,800 square feet.
Area of exhaust inlet....... = 158 square feet.
Bore of circulating discharge pipes .... = 32 inches.
Diameter of tunnel shafts... = 20 inches external, 10 inch hole.
Diameter of propeller shafts = 22 inches external, 10 inch hole.
Boilers, working pressure, 195 pounds per square inch.
23 double-ended boilers, 17 feet 6 inches mean diameter by 22 feet long.
2 single-ended boilers, 17 feet 6 inches mean diameter by 11 feet 4 inches long.

Total number of furnaces .... = 192
Total grate surface .... = 4,048 square feet.
Total heating surface .... = 158,352 square feet.
Total length of boiler rooms .... = 336 feet.
Total length of main and auxiliary engine rooms .... = 149 feet 8 inches.

With regard to the running of this large machinery and boiler installation, it may be of interest to members to give detailed particulars of the forced lubrication system, and of the system of feed heating and supply to the boilers. Each of these systems demanded that adequate provision be made to meet all possible contingencies, and thus enable the engineers in charge to be free to attend to the numberless duties connected with the supply of electric power and lighting, the supply of hot and cold, fresh and salt water throughout the ship, the pumping of the bilge and of the ballast compartments, and last, but not least, the supervision of the large army of stokers or firemen and trimmers, and the regulation and distribution of the coal supply from the various bunkers.

Regarding the forced lubrication system, of which a diagrammatic sketch is given in Fig. 3, the following statement gives the weights of the various revolving parts, together with the size of bearings and the pressure on same:

Weight of one high-pressure turbine rotor complete.. = 86 tons.
Weight of one low-pressure turbine rotor complete... = 120 tons.
Weight of one astern turbine rotor complete........ = 62 tons.

	Main Bearing Journals. Diameter.	Main Bearing Journals. Effective Length.	Pressure Per Square Inch of Bearing Surface.	At 190 Revolutions, Surface Speed of Journal.
High-pressure rotor	27½ inches	44¾ inches	80 pounds	1,350 feet per minute
Low-pressure rotor	33½ inches	56½ inches	72 pounds	1,650 feet per minute
Astern rotor	24½ inches	34¾ inches	83 pounds	1,200 feet per minute

A large main drain or reservoir tank is placed amidships, low down in the engine room, in such position that the oil from all the bearings readily flows into it; the oil is pumped from this tank by four direct-acting single-cylinder pumps, through a system of filters, to gravitation tanks placed in the engine room casings, about 26 feet above the bearings. These tanks are of sufficient capacity to maintain the oil supply to the bearings for ten or eleven minutes after the complete stoppage of all the pumps. There is a separate and distinct system of supply and gravitation pipes to the bearings on each side of the ship, with cross connections, so that, in the event of any defect arising on one side, it can be at once shut off, and the whole supply to all the turbines directed through the other side. Gages showing the pressure in the oil pump discharges to the filters, and also the pressure in the gravitation pipes to the main bearing journals and thrusts, are fitted up at the starting platform as well as at the pumps, these latter being placed in an easily accessible part of the center engine room. A pressure gage is also fitted at each bearing, and, in addition, the drain

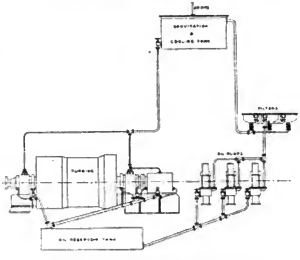


FIG. 3.—DIAGRAM OF FORCED LUBRICATION SYSTEM.

or discharge from the bottom reservoir from each bearing and thrust is led through a glass-sided lantern-shaped receiver, so as to make the flow visible, and a thermometer fitted up at this point enables the temperature of the oil from each of the twelve main bearings and four thrust blocks to be taken and recorded, the practice being to log the temperature hourly. In the gravitation tanks are placed copper coils of a total surface of 1,335 square feet, through which cold sea water is circulated, and this surface suffices to maintain, at a temperature not exceeding 30 degrees above that of the engine room, the 4,700 gallons of oil in circulation. Each coil is self-contained and withdrawable, so that a leakage of sea water from pitting or other cause can readily be located and repaired without interfering with the general working of the oil supply. There are also reserve oil tanks having a total capacity of 4,200 gallons for use in case of emergency.

Three of the six oil pumps, the discharges from which are all cross-connected, are ample for all the necessary oil supply, but four are kept in use, so that no risk is run in the event of the failure of any single pump not being at once noticed.

With reference to the feed system, shown diagrammatically in Fig. 4, it should be explained that all the auxiliaries in the ship, excepting the turbo-generators and the evaporators, exhaust into a general system of auxiliary exhaust piping connected to the surface feed heaters, auxiliary condensers and

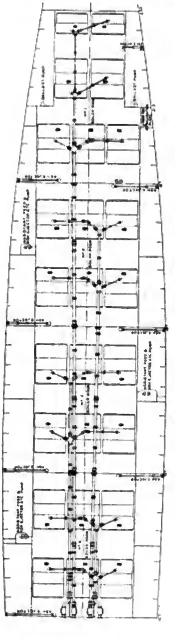


FIG. 2.—ARRANGEMENT OF BOILER ROOMS IN LUSITANIA, SHOWING TWENTY-FIVE CYLINDRICAL BOILERS.

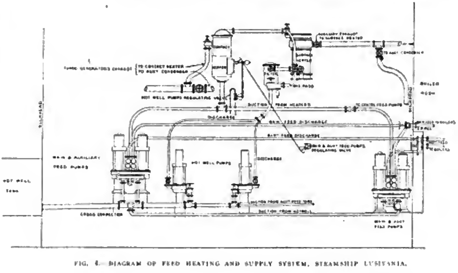


FIG. 4.—DIAGRAM OF FEED HEATING AND SUPPLY SYSTEM, STEAMSHIP LUSITANIA.

atmosphere. The turbo-generators exhaust into an entirely distinct system of piping connected to the contact feed heaters, auxiliary condensers and atmosphere. From Fig. 4 it will be seen that the hot-well pumps draw from the hot-well and discharge through two feed filters to the two surface feed heaters, and thence to the contact heaters; these latter constitute the usual feed receivers, and are fitted with float gear, controlling not only the steam supply to the main feed pumps, but also to the hot-well pumps. In addition, the hot-well pumps are controlled by float gear in the hot-well tanks—the latter, in case of a shortage of water supply, to prevent the pumps running away, and the former precluding the possibility of water being forced back to the turbo-generators, should the non-return valve in the steam inlet to the contact heater fail to act in the event of the feed pumps suddenly slowing.

In most large merchant ships, on account of accidents which have occurred, it has been the general practice to lead the exhaust from the electric engines direct to the main or auxiliary condensers only, to insure steady running of the dynamos, and to prevent the possible passing back of water from other auxiliary engines into the cylinders of the electric engines. In this present case the electric installation is so large, and the temperature of the hot-well, due to the high vacuum maintained, so low, that it was considered to be essential to utilize this exhaust for the heating of the feed water, and, by adopting this duplicate system of feed heaters and hot-well control, this end has been attained with a minimum of risk.

Owing to the very great length of feed supply pipes from the feed pumps to the forward boilers, there was considerable speculation as to whether the feed supply to each boiler room would have to be entirely distinct. Had this been so, each pair of feed pumps would have required to be worked entirely independently of the others, and, in the event of any hitch occurring, one of the two pairs of stand-by pumps would have had to be at once connected to the particular boiler room in question. In actual running, however, it was found that the four main feed supply pipes could be cross-connected and made common, thus making any demand for special care and vigilance on this score unnecessary.

With regard to the maintenance of steady steam at sea, although innumerable types of rocking and self-cleaning firebars have been devised and tried in connection with automatic stokers, none of these has been found to give satisfactory results in merchant vessels. The stoking, and especially the cleaning of the fires whenever hard steaming is required, is the same as it was fifty years ago, and, as a consequence, is dependent on the willingness and ability for work of each unit of the stoking complement of the ship.

(To be Concluded.)

THE SECOND CLASS CRUISER GLADIATOR, SUNK IN COLLISION WITH THE ST. PAUL.

THE SINKING OF THE GLADIATOR.

On April 25 occurred a disaster almost without parallel in naval history, in that a warship in collision with a merchantman was sunk. The instances of this sort have been extremely rare, the greater damage coming usually upon the more lightly plated vessel of commerce. In the present case, however, the American Line steamer *St. Paul*, which had just left Southampton for New York, and was proceeding at slow speed through the Solent in the midst of a heavy snowstorm and fog, rammed the British cruiser *Gladiator* on the starboard side between the bridge and the forward funnel, to such effect that within about twenty minutes the *Gladiator* touched bottom. Fortunately, the swing of the tide, aided by her engines, sent the vessel close to shore before she finally went down, and a considerable portion of the hull, including one of the propellers, remained above water, as she rested on her beam ends. One of our photographs shows her in this condition.

The liner cut clear through the side of the war vessel, and

THE WRECK OF THE GLADIATOR—THE SHIP ON HER BEAM ENDS—BATTLESHIP PRINCE GEORGE IN BACKGROUND.
(Photograph, Stephen Cribb, Southsea.)

in backing away carried off one plate of the protective deck (weighing considerably more than a ton), a watertight door, some coal bunker casings, and a number of sections of angles joining these plates together. These were left embedded in the hole made in the liner's bow by the resistance of the protective deck of the cruiser, and are clearly shown in the small detail in the upper corner of one of our illustrations. The damage to the liner was considerable, but she was in no

THE AMERICAN LINER ST. PAUL IN DRY DOCK AT SOUTHAMPTON, SHOWING DAMAGE TO BOW.

danger, because of the fact that her forward collision bulkhead intervened between the apertures and the main part of the hull. On the starboard side, however, indentations, including even the splitting of plates, ran back some 45 feet from the bow above the waterline. These were due, doubtless, to projecting guns, or something of that sort, on the cruiser.

The impact was almost at right angles. At the request of the captain of the cruiser, the *St. Paul* was backed out of the

CLOSE VIEW OF THE DAMAGED BOW OF THE ST. PAUL.

gap instead of being allowed to block the gap and push the cruiser ashore into shallow water. As soon as the vessels were clear, the *Gladiator* began to list heavily to starboard, and took the ground in about 6 fathoms, at a quarter of a mile from shore. The *St. Paul* lowered boats to assist in the saving of the crew of the *Gladiator*, many of whom were injured, and four or five of whom actually boarded the liner at the moment of collision. Unfortunately, these boats were swept far away by the tide and wind before they could be used, and those of the *Gladiator*, being launched from her high side, fell against the side of the vessel, and were with difficulty put afloat. The loss of life is said to have been twenty-eight, including one officer, all of whom belonged to the *Gladiator*.

The cruiser was launched in 1896 at Portsmouth, having a displacement of 5,750 tons, a length between perpendiculars of 320 feet, a beam of 57 feet 6 inches and a draft of 24 feet. With twin-screw engines of 10,000 horsepower the vessel made 19 knots. Steam was furnished by Belleville boilers. The battery included ten 6-inch guns and eight 12-pounders, besides six smaller guns and three torpedo tubes.

The *St. Paul* is a twin-screw passenger steamer, launched in 1895 by William Cramp & Sons, Philadelphia. She measures 535 feet 6 inches between perpendiculars, with a beam of 63 feet and a draft of 26 feet 8 inches. Her registered tonnage is 11,629. She has quadruple expansion engines of 20,000 horsepower, giving a maximum speed of 21.5 knots.

The battleship *Michigan* was launched by the New York Shipbuilding Company, Camden, N. J., May 26. She is the first American "all big gun" battleship, has a displacement of 16,000 tons, and the main battery will consist of eight 12-inch rifles, all training on one broadside.

RESULTS OF FURTHER MODEL SCREW PROPELLER EXPERIMENTS.*

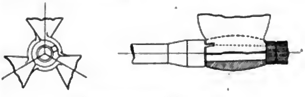
BY R. E. FROUDE, F. R. S.

GENERAL SCOPE OF EXPERIMENTS.

The experiments on model screw propellers, with which this paper is concerned, are an extension of those made at the Torquay tank in 1884. Since the present experiments, while covering a good deal of fresh ground, covered also the whole ground of the previous ones—so far, at least, as is relevant to present-day conditions—and were carried out, in some ways, on improved methods, their results may be said to supersede those of the earlier experiments.

The principal points in which the present experiments exceeded in scope the previous ones were as follows:

(i.) Lower values of pitch ratio included. [The highest values included in the old experiments were at the same time discarded; but these were quite outside the range of present practice.] This downward extension of the pitch-ratio range in the new experiments brings in pitch ratio as an important factor affecting efficiency, since it is in the region below the range of the old experiments that pitch ratio influences efficiency in an important way.



SCALE OF DECIMALS OF A FOOT.

0 ·1 ·2 ·3 ·4 ·5

FIG. 4. BOSS OF MODEL PROPELLERS.

(ii.) Three-bladed as well as four-bladed propellers were tried [in the old experiments the model propellers were all four-bladed].

(iii.) Variation of width proportion of blade was tried, ranging from that of the old experiments up to about twice that width.

(iv.) Difference in blade shape; by including the wide-tip pattern, in addition to the elliptical pattern solely used in the old experiments.

For outlines and sections of blades and shape of boss, etc., see Figs. 1 to 4. For elliptical propellers, the developed outlines are ellipses of major axis equal to propeller radius, and the blade-width ratio is the ratio of minor to major axis. The developed outlines of the wide-tip propellers are formed from elliptical outlines for the same reputed blade-width ratio by making, for any radius, $= r$,

$$\frac{\text{Wide-tip width ordinate}}{\text{Elliptical width ordinate}} = \left(\frac{1}{2} + \frac{r}{R}\right)$$

where $R =$ propeller radius. Hence, for the same blade-width ratio, the wide-tip and elliptical outlines have the same total area. For the purpose of the analysis, and for relating disk-area ratio to blade-width ratio, the entire area of the elliptical or wide-tip outline thus obtained is reckoned, without any allowance for portion covered by boss.

METHOD AND GENERAL CONDITIONS OF EXPERIMENT.

Method.—The experiments were the usual kind of what are described as screw experiments "in open," namely, in undisturbed water (without model in front), the screw being mounted on the forward end of the shaft which drives it, the whole advancing through the water at a prescribed speed, the

* Read before the Institution of Naval Architects, London, April 10, 1908.

PARTICULARS OF REGULAR SERIES OF MODEL PROPELLERS.

Reference No.	Blade Width Ratio.	Disk Area Ratio.	Pitch Ratio.
THREE-BLADED ELLIPTICAL.			
1	.4	.3	.885
2	.55	.413	.885
3	.7	.525	.885
4	.4	.3	1.09
5	.55	.413	1.09
6	.7	.525	1.09
7	.4	.3	1.315
8	.55	.413	1.315
9	.7	.525	1.315
10	.4	.3	1.53
11	.55	.413	1.53
12	.7	.525	1.53
THREE-BLADED, WIDE TIP.			
13	.6	.45	.885
14	.8	.6	.885
15	1.0	.75	.885
16	.6	.45	1.09
17	.8	.6	1.09
18	1.0	.75	1.09
19	.6	.45	1.315
20	.8	.6	1.315
21	1.0	.75	1.315
22	.6	.45	1.53
23	.8	.6	1.53
24	1.0	.75	1.53
FOUR-BLADED, ELLIPTICAL.			
25	.4	.4	.885
26	.55	.55	.885
27	.7	.7	.885
28	.4	.4	1.09
29	.55	.55	1.09
30	.7	.7	1.09
31	.4	.4	1.315
32	.55	.55	1.315
33	.7	.7	1.315
34	.4	.4	1.53
35	.55	.55	1.53
36	.7	.7	1.53

screw driven at prescribed revolutions per minute, and the thrust and turning moment being measured. Each set of experiments on each screw consisted of some twenty runs at the same speed, at different slip ratios; including a run or two, at beginning and end, with screw off, for eliminating constant resistances of apparatus. This series of runs, which occupied some 2½ hours in the middle of each day, was daily both preceded and followed by a series of experiments, with truck stationary and a turbine brake dynamometer substituted for the screw, to measure the "working" friction of the driving gear.

Diameter of Screws.—Uniformly 0.8 foot [as compared with 0.68 foot in the old experiments].

Immersion (to center of shaft).—Uniformly 0.64 foot [viz., 0.8 of the diameter, as in the old experiments].

Speed of Advance.—300 feet per minute [as compared with 200 feet per minute in the old experiments]. This was the highest speed at which it would have been possible to obtain the desired range of slip ratio, without overstraining the driving gear.

Boss of Screws.—The boss common to all the model screws (see Fig. 4) was (as usual in our model screws) of the smallest practicable character. Some special experiments made with ordinary large bosses showed the effect of a large boss to be material, partly in its resistance, and still more in an increase of revolutions per minute, due presumably to stream line action; but, as both these effects are intimately involved with those of the bearings or shaft tubes, which in the ship immediately precede the propeller, it seems best, where all these features are absent, as in the experiments with which we are here concerned, to suppress the boss so far as possible.

Skew-Back of Blades.—The model screws employed in the regular series of experiments were without skew-back; but experiments were made with four additional model screws having a skew-back of 15 degrees on the driving face, otherwise similar to four of the regular series, and the skew-back was found to make no material difference in the result. These four skew-back screws were generally similar to Nos. 7, 8, 9 and 31 of the list.

ANALYSIS AND REDUCTION.

Basis.—It is perhaps in the system of analysis and reduction of the results, more than anything else, that the present series

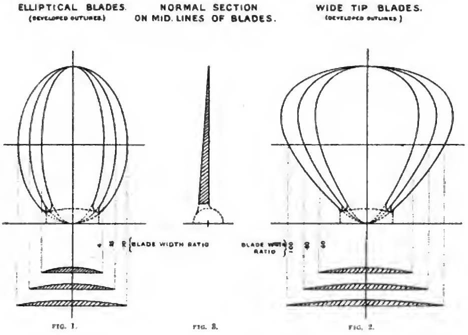


FIG. 1. FIG. 3. FIG. 2.

of experiments differs from the previous. The introduction of width proportion and shape of blades as varying conditions, and the recognition of pitch ratio as having an important influence on efficiency, in any case necessitated some change; but also, the possibility had presented itself to me, in course of study of the results of the previous experiments, of so harmonizing the results that the relation of thrust to revolutions per minute could be calculated for a screw of any diameter and pitch, by means of a simple formula, without using any diagrams or tables at all.

Apart from the convenience of being able to embody the results in such a form, it is, of course, always desirable, when possible, in harmonizing the minor and accidental irregularities of a system of experiment results, to use a mathematical expression which has some at least approximate theoretical relevance, in place of a mere graphic fairing of spots by a curve. The analysis, then, of the series of thrust and efficiency curves yielded by the experiments on the individual model screws, was in the first instance based on the following simple formula for thrust in terms of revolutions per minute:

$$T = a\ R^2 - b\ R \qquad (1)$$

Where T = thrust; R = revolutions per minute; a = a coefficient depending on dimensions, etc., of screw; b, one depending on the speed and pitch.

This formula embodies the following idea, which under certain ideal conditions would be theoretically correct:

Imagine an elementary blade mounted on the end of a resistless spoke, revolving at circumferential speed R, and standing at an angle α from the plane of rotation; the whole having

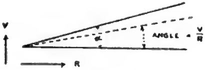


FIG. A.

an axial speed V relatively to the fluid. Then (see Fig. A), assuming α "small," if R_0 be the circumferential speed for zero thrust, we may put

$$a = \frac{V}{R_0},$$

and

$$\text{Thrust} = T = (\text{say})\,k\ R^2\left\{a - \frac{V}{R}\right\} = \left\{k\frac{V}{R_0}\right\}R^2 - (kV)R.$$

In any screw, revolving in still water at various rotary speeds without axial advance, the thrust will, of course, be proportional to the square of the rotary speed. This fact is expressed by the term $a\ R^2$ of the formula, represented by the ordinates of the parabola $A\ B\ C\ D$ in Fig. B. If now we suppose the screw, while still revolving as before at various rotary speeds, to have a definite forward axial linear speed of advance V as well, there will, of course, then be a certain definite rotary speed (revolutions per minute = R_0, say), at which the thrust will be zero, below which it will be negative, and above which it will be positive, but of decreased amount. And the formula expresses this decrease of thrust in terms of revolutions per minute, by the negative term $b\ R$, represented by the ordinates to the straight line $A\ C\ E$, cutting the parabola at C, namely, at R_0, the revolutions of zero thrust. Thus the straight line $A\ C\ E$ becomes in effect the zero line for the curve $C\ D$, regarded as the thrust curve for the speed of advance V; and, similarly, the same parabola $A\ B\ C\ D$ may be made to furnish the thrust curve for the same screw at any speed, by drawing accordingly the sloping line $A\ C\ E$ which represents the term $(-\ b\ R)$ of the formula.

Even before the experiments herein described were begun, I had found that this formula expressed the thrust curves of experiment, in general, remarkably well; since, therefore, a new reduction was in any case necessary, this formula was unquestionably the right basis for, at any rate, the primary analysis of the results.

Thrust.—Continuing the study of the formula, it will be seen that if, as is most convenient for such analysis, and as has been done in this case, we take as a conventional measure of the pitch the travel per revolution at the revolutions per minute R_0 (of zero thrust), so that

$$P = \frac{V}{R_0},$$

and, again, observing that for zero thrust at revolutions = R_0 we must have $a\ R_0^2 = b\ R_0$, we can eliminate the coefficient b in terms of a, V and P. And, assuming the coefficient a to have

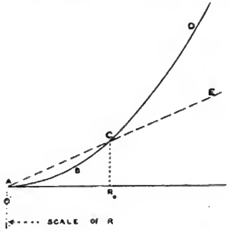


FIG. B.

been correctly obtained for a screw of specific design and unit diameter (diameter = D = 1), we obtain from equation (1) above, the following two alternative equations for thrust:†

$$T = \frac{a}{p^2}D^2\ V^2\frac{S}{(1-S)^2} \qquad (2)$$

$$T = a\ D^4\ R^2\ S, \qquad (3)$$

where

$$p = \frac{P}{D},$$

or pitch ratio, and S = slip ratio as ordinarily reckoned, viz.: $(R - R_0) \div R$. The former of these, expressing thrust in terms of speed and slip ratio, is perhaps the most intelligible; while the latter is often more convenient for computation.

To enable the thrust, for given speed and revolutions, to be

---

† Substituting, in equation (1), $a\ R_0$ for b, we get—

$$T = a\ R^2 - a\ R_0\ R = a\ R^2\left(1 - \frac{R_0}{R}\right) = a\ R^2\ S.$$

This is for unit diameter. For propellers of uniform design, area increases as (diameter)², and, for given revolutions, so does thrust per unit of area as affected by speed; thus giving equation (3) of text. Next, remembering that—

$$(1 - S) = \frac{V}{R\ P},$$

and substituting for R in equation (3), we get—

$$T = a\ D^4\ V^2\frac{D^2\ S}{P^2\ (1-S)^2} = \frac{a}{p^2}\ D^2\ V^2\ \frac{S}{(1-S^2)}.$$

N.B.—In the analysis of the model propeller results, V has been taken in hundreds of feet per minute, and R in hundreds of revolutions per minute.

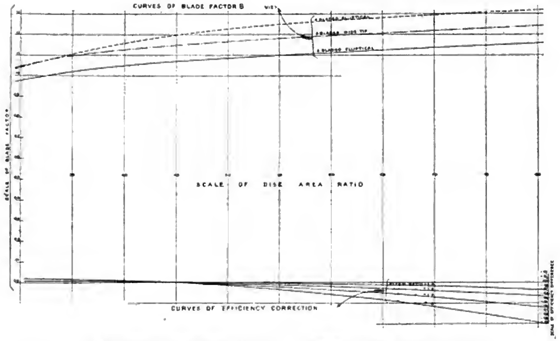


FIG. 5.—CURVES OF BLADE FACTOR AND EFFICIENCY CORRECTION ON BASE OF DISK AREA RATIO.

calculated by either of these formulæ for a propeller of any given design and dimensions, it is needed only to determine the coefficient a as affected by difference of design, the principal elements in which may be taken to consist in pitch ratio, type and blade width proportion.

It was found that the effects of these two principal elements might be taken as independent of one another, and that, as regards pitch ratio, a might be most correctly taken as proportional to $p\ (p + 21)$. As regards type, the value $\dfrac{a}{p\ (p + 21)}$, which, as just seen, is constant for varying pitch ratio, was taken as the expression for the "blade factor" B; the purpose of which is to denote what may be called the thrust capacity of the propeller, as dependent on type, *i. e.*, whether three-blade elliptical, three-blade wide-tip, or four-blade elliptical; and within each of these types, on width proportion of blade. The value of this blade factor B, as obtained from

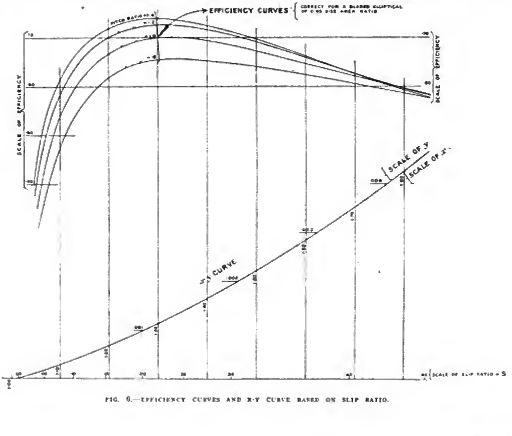


FIG. 6.—EFFICIENCY CURVES AND X-Y CURVE BASED ON SLIP RATIO.

the experiments, and as dependent on these variants, has been indicated by the ordinates of three curves (see Fig. 5) respectively proper to the three types just mentioned, on an abscissæ scale representing blade width proportion, as indicated by "disk area ratio," namely, ratio of total blade area to disk area.

At the same time, for a final test of the formula of equation (1), as accurately expressing the variation of thrust with revolutions, the thrust values of all the individual propellers, at a series of slip ratio values, were carefully compared with thrust values calculated by formula; and on this information the thrust formula was corrected by multiplying the right-hand side by 1.02 (1 — .08 S). Making this correction, and also substituting for a its value in terms of the blade factor B, just referred to, equation (2) becomes the final thrust formula, as follows:

$$T = D^2 V^2 \times B \frac{p + 21}{p} \times \frac{1.02\, S\,(1 - .08\, S)}{(1 - S)^2}. \qquad (4)$$

To facilitate calculations, a curve was computed expressing the last factor (involving S only) as an ordinate ($= y$) to a base ($= x$), expressing revolutions and pitch relatively to speed, as indicative of the slip ratio S. This curve, commonly called the "x y" curve, appears in Fig. 6. Conveniently for ship screw calculations, the numerical coefficients used in the computation of this curve were chosen for expressing, not thrust, but "thrust horsepower" (or $T\,H\,P$) $= H$; speed $= V$, in knots; revolutions $= R$, in hundreds; diameter $= D$, in feet. We thus get as the expressions for x and y as follows:

$$x = \frac{R\,p\,D}{V}\left[= \frac{1.0133}{1 - S}\right] \qquad (5)$$

$$y = \frac{p}{B\,(p + 21)} \times \frac{H}{D^2 V^3}\left[= .0032162 \frac{S\,(1 - .08\, S)}{(1 - S)^2}\right] \qquad (6)$$

In regard to the expression for x

$$1.0133 = \frac{6.08}{6} = \frac{\text{speed in hundreds of feet per minute}}{\text{speed in knots}}.$$

In regard to that for y; from equation (4),

$$\frac{T}{D^2 V^2}\left[= \frac{T\,V}{D^2 V^3}\right] = B \frac{p + 21}{p} \cdot \frac{1.02\, S\,(1 - .08\, S)}{(1 - S)^2}.$$

Then, converting V from 100's feet per minute into knots, and $T\,V$ into H, this equation becomes

$$\frac{H \dfrac{33.000}{100}}{D^2 \left(\dfrac{101.33}{100}\right)^3} \times \frac{p}{B\,(p + 21)} = \frac{1.02\, S\,(1 - .08\, S)}{(1 - S)^2}.$$

or

$$\frac{H}{D^2 V^3} \times \frac{p}{B\,(p + 21)} = .0032162 \frac{S\,(1 - .08\, S)}{(1 - S)^2}.$$

(*To be Concluded.*)

An unusually large number of new ships have visited New York during June. They include the Holland-America liner *Rotterdam*, 24,170 tons; the French liner *Chicago*, 11,000 tons; the Russian-American liner *Russia*, 14,000 tons; the North German Lloyd liner *Prinz Friedrich Wilhelm*, 17,500 tons, and the *Principe de Udine*, of the Lloyd Sabaudo.

The Tug Monomack.

This tug was launched from the yard of the Atlantic Works, East Boston, on March 7. She took her maiden plunge sideways into a slip which is just wide enough to permit the travel of a marine railway cradle. The boat is owned by the Merri-

THE TUG MONOMACK GOING OVERBOARD.

mack River Towing Company, and is to be used for general towing. Her length over all is 77 feet 6 inches, with a beam of 17 feet 2 inches; depth of hold, 7 feet 8 inches, and a draft of 7 feet 6 inches. H. M. Smith.

Transatlantic Steamship Records.

The first steamship record of any vessel crossing the Atlantic was the twenty-five days occupied by the *Savannah* in 1819. Nineteen years later the *Great Western* crossed from Liverpool in fourteen days. In 1840 the Cunard steamer *Britannia* reduced the record to ten days and six hours. In 1852 the Collins Liner *Arctic* made the trip in nine days and seventeen hours. Other records are as tabulated:

	Days.	Hrs.	Min.
1856—*Persia* (Cunard)	9	1	45
1866—*Scotia** (Cunard)	8	2	48
1869—*City of Brussels* (Inman)	7	22	3
1875—*City of Berlin* (Inman)	7	15	48
1877—*Britannic* (White Star)	7	10	54
1880—*Arizona* (Guion)	7	7	23
1882—*Alaska* (Guion)	6	18	37
1884—*Oregon* (Cunard)	6	11	9
1885—*Etruria* (Cunard)	6	4	43
1889—*City of Paris* (Inman)	5	19	18
1891—*Majestic* (White Star)	5	18	10
1891—*Teutonic* (White Star)	5	16	31
1893—*Paris* (American)	5	14	24
1893—*Campania* (Cunard)	5	12	7
1907—*Lusitania* (Cunard)	5	..	54
1907—*Lusitania* (Cunard)	4	18	40
1908—*Mauretania* (Cunard)	4	20	15

This does not include records from Southampton or Plymouth.

* The last of the paddle-wheel steamers.

The Largest Ships in the World.

A German contemporary has listed all the vessels of over 20,000 tons now afloat or building, there being nine in service, one other (the *Rotterdam*) very nearly ready, and four

others in various stages of construction or "anticipation." This makes a total of fourteen. Four of the nine in service, and one of those under construction, are accredited to the White Star Line, all having been built by Harland & Wolff, of Belfast. The Hamburg-American Line is accredited with two in service and two under construction, three of which total were built by Harland & Wolff; the other was built by the Vulcan Works at Stettin. The Great Northern Steamship Company has one vessel, built in the United States; the Cunard Line has two ships, built on the Clyde and the Tyne, respectively; the Holland-America Line has one ship, practically finished, by Harland & Wolff, and the North German Lloyd Line is having one large vessel built by the Vulcan Works.

Omitting the four vessels on which only slight progress has been made, we find ten immense steamers, aggregating 246,309 tons gross, or an average of 24,631 tons. Six fly the British flag, two are German, one American and one Dutch.

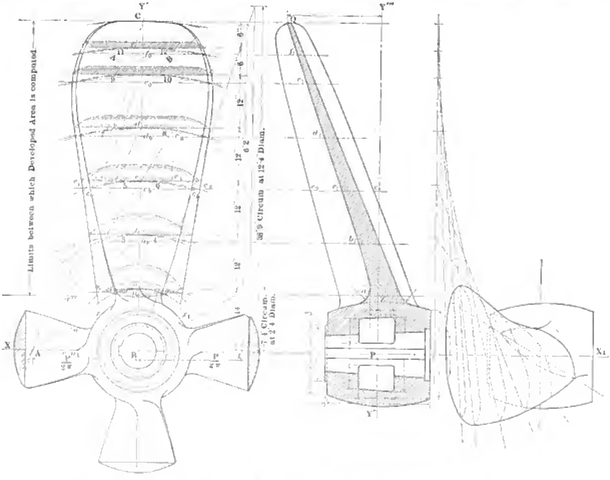


FIG. 1. THE DEVELOPMENT OF A PROPELLER WHEEL OF 12 FEET 4 INCHES DIAMETER AND AN EQUAL PITCH.

THE LAYING OUT OF PROPELLER WHEELS.

BY CHARLES A. LISCH.

There is no one subject within the limits of the science of naval architecture which offers more interest to the investigator than the propeller wheel. The mist which has obscured the subjects of resistance and propulsion is rapidly vanishing before the investigations carried on at the experimental tanks, under such investigators as Durand, Taylor, Rota and Froude.

It is not only with regard to these two subjects that diversity of opinion exists, but in the delineation of the wheel as well. It should be the aim of the designer to so delineate the wheel that the contour of drawing and that of the pattern shall be exactly similar. If such is not the case, why exercise such care in reading the areas, the ratios, etc.? It seems to be the rule for the drawing to show one shape and the pattern another. Hence, as the developed area shown on the drawing and the area of blade are different from those in metal, of what use are all the refinements into which designers enter in designing a wheel? If we take a drawing of a wheel, and, after the ship has undergone her trial trip, compute from the drawing the characteristics of the blade, and use them in the computation for data required in such cases; then, if the wheel as built is not of the shape as shown on the drawing, of what use would there be in using this information for designing other ships? The writer had this very forcibly impressed upon him some time ago.

Fig. 1 shows a wheel where the drawing and pattern were exactly similar. Fig. 2 shows the same blade, as drawn by a well-known method. It is not the object of this paper to discuss the various methods or to criticise their faults and virtues, but to submit to the readers of this journal a method of delineating the blade, and a method of making the pattern whereby the two agree in every detail.

Let us take the wheel shown in Fig. 1. This wheel is 12 feet 4 inches in diameter and 12 feet 4 inches in pitch. We will assume that we are given the required developed area, and that we have gone through the preliminary work, and have decided on shape of blade as shown, and are prepared to make the working drawings for same.

We first draw the horizontal line XX_1. This line is the axis

of our shaft. Now draw a line $Y\,Y''$ at right angles to $X\,X_1$, intersecting the axis in B. About this center line will be drawn our athwartship view, or in other words, these lines lie in an athwartship plane. From the center B we set off on either side of the vertical, or its intersection, a distance equal to

$$\frac{\text{Pitch}}{2\pi} = \frac{P}{6.2832}$$

From B we set off on $Y\,Y'$ a distance $B\,C$, equal to the radius of the wheel. In our case this is 6 feet 2 inches. Now,

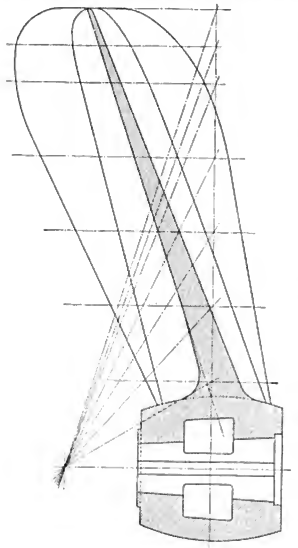


FIG. 2.

from B we set off a distance equal to the radius of the hub, or we can ignore the hub for the present, and set off on $Y\,Y'$ from the point B the distance Ba, Bb, Bc, etc., as shown. It is better to decide on the hub and to sketch in its contour.

From the points a, b, c, etc., we draw a series of lines to A (these lines are termed pitch lines), and through the points a, b, c, etc., we describe elliptic arcs, the radii of these arcs all lying on $Y\,Y'$ produced. Set off from a, b, c, etc., the *required distances*, as 1, 2, 3, 4, etc., these distances being obtained from our preliminary work, where account is taken of the requirements for blade area. Now pass a fair curve through these points, and we obtain the contour of the developed blade. The area included within this boundary should be the developed area of the wheel as built, except in so far as slight variations would modify it.

With B as center and radius Ba, Bb, Bc, etc., describe circular arcs (the elliptic arcs project on an athwartship plane into circular arcs). We can now proceed to lay down the projected area by one of two methods. We can, from the points $c_3\ c_3$, project a horizontal line parallel with the axis, until it intersects the circular arc, and thus get points for the projected area; or we can simply produce the pitch line, for instance, through c, and take a distance $c_6\ c_6$, equal to $c'\ c''$, and lay off from c_6 the distances $c_6\ c_6$, $c_6\ c_6$, proceeding thus for each arc, the result in either case being precisely the same. Take the former method. Project back from c_3 to c_6, and repeat for each arc, passing a curve through the points thus obtained. We have at once the contour of the projected view, and the area inclosed will give the projected area. Now for the fore-and-aft plane.

Draw the perpendicular $Y'''\ Y''''$ intersecting the axis at P. Set off $Y''''\ Q$ equal to the "fall back" or skew. From Q draw a straight line QZ, intersecting $Y'''\ Y''''$ in Z. [Note—It is simply the desire of the man having the wheel made that the generating line shall intersect at this point. It is not any easier for the pattern maker, and there is no reason why it should not intersect $Y'''\ Y''''$ at P.]

From the points of intersection of the elliptic arcs with the boundary line of the blade on the athwartship plane, draw horizontal lines parallel with the axis to $a_1\ b_1\ c_1$, etc. Set off on either side of the generating line $Q\ Z$ the distance $A\ u$ or $c\ c_6$. This gives the point of division, and passing a curve through these points we have the contour of blade when viewed from a vertical plane parallel with the shaft.

The thickness of the blade at tip and root having been decided, as well as the successive blade sections in the preliminary work, we proceed to draw them in, and the remaining details can now be filled in. We have used the elliptic arc for our developed area. It will be shown later that the pattern is built up in precisely the same way.

Now to prove the correctness of the construction and the reasoning. It is evident that a straight line moving uniformly around an axis which it intersects at right angles (or inclined at any angle), and advancing uniformly along the axis will sweep out a surface. This surface is termed a helicoid. The first line is termed the generating line or generatrix; the second the axis. Now it is apparent that any point in the generating line will trace out a helix. In other words, the locus of any point in the generatrix, as it moves in obedience to the law expressed above, will be a helix. Keeping in mind the idea of the surface, we see that the locus of the point must be in the surface.

If, for one complete revolution of the generatrix, every point moves through equal distances in the direction of the axis, the pitch will be uniform, and hence the surface is a surface of uniform pitch. This is the surface used for deriving the face of a blade of uniform pitch. It can be proved that a helix traced by any point in the generating line is a curve of intersection of a cylinder with the screw surface. Take any number of points on the generatrix; each of these points will limit the radius of a cylinder. The cylinders, having the same axis, are termed co-axial.

We observe from Fig. 3 that as the diameter of the cylinder increases, the pitch being constant, the angles of the helix decrease.

Let P = pitch; r = radius of cylinder; α = angle of helix.

$$\text{Then } \tan\alpha = \frac{P}{2\pi r}$$

Now, co-axial cylinders intersect the screw surface in helices, and, as we have seen, make certain angles with the

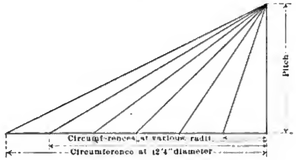


FIG. 3.

axis. If we pass planes through the middle point of the helical curve, keeping the same angle with the axis, we find that they will intersect these planes in elliptic arcs. In the delineation of the blade, we swing these elliptic arcs at all radii around the common center line B C until they all lie in the same plane. This, of course, makes their major and minor axes coincident; but, as shown, they are of different length. We can either compute the radii of these elliptic arcs, or we can obtain them by construction.

Take the arc passing through b, for example. We have seen that the distance Bb is the semi-minor axis. The distance bA is the semi-major axis. The distance $\frac{P}{2\pi}$ locates the foci of all the elliptic arcs. Let $oy = Bb$, and $ox = bA$, Fig. 4. Complete the triangle. Produce oy in both directions. With ox as distance, set off on oy produced, $oy' = o\ x$. Set off on yx, from y, the distance $y\ y' = yu$. Now, $y\ u = y\ y' = o\ x - o\ y =$ difference between semi-major and semi-minor axis. Bisect $u\ x$, and produce the perpendicular to intersect $o\ y$ produced, as at w; then $w\ y$ is the radius of the elliptic arc.

To prove the correctness of this construction. In the elliptic arc passing through b, Fig. 5, take any point u. From u draw the radii vectors y, y'. Now, bA is the length of pitch line, or length of semi-major axis. We know that the sum of the focal radii, or radii vectors, is equal to twice the length a, or to twice the length of pitch line. As $\frac{P}{2\pi}$ locates the

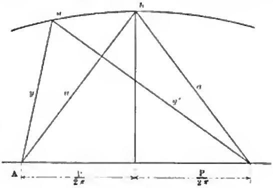


FIG. 5.

foci of all elliptic arcs about Y Y', Fig. 1, and y, y' are focal radii, or radii vectors, as above; therefore, $y + y' = 2\ a$.

The writer has been frequently asked why, when a blade has a fall back, should not the developed area be raised above the projected area? In other words, why should not the developed area be drawn as though Q Z were swung around Z until it was at right angles to the axis of the shaft. This would make the contour of blade show above its projected view.

If two straight generating lines, such as OZ and OZ', Fig. 6 (OZ being at right angles to the axis, and O Z' inclined to O Z at any angle), move together, generating screw surfaces, the form and pitch of both being equal, the helices of the two surfaces so formed must be exactly similar. Now, these surfaces will always be at a constant distance from each other, and for any radius such as Ba, Fig. 1, represented by r in Fig. 6, this distance will, therefore, be $Ba \times \tan \theta = r \times \tan \theta$, where θ is the angle of inclination of the generating line.

Therefore, when O Z' at any radius leaves the surface, O Z at the same radius leaves its surface. Therefore the surface

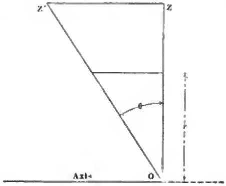


FIG. 6.

formed by O Z will be precisely the same as that formed by O Z'. Taking Fig. 1, for instance, the developed area formed by Q Z will be precisely the same as that formed by Y''' Z. We see, therefore, that a blade generated as above is obtained simply by setting the helices at intersected distances aft, corresponding to points selected. This can be further proved by laying down a template, and fitting the same to the pattern. This shows that the athwartship projection for the same developed area is independent of the fall-back or skew.

(To be Concluded.)

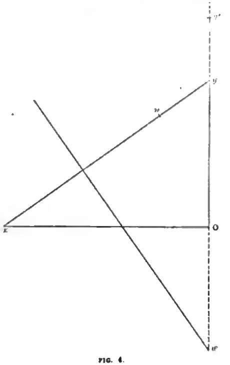


FIG. 4.

INTERNATIONAL MARINE ENGINEERING

Published Monthly at

17 Battery Place New York

By MARINE ENGINEERING, INCORPORATED

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President

E. L. SUMNER, Secretary

and at

Christopher St., Finsbury Square, London, E. C.

E. J. P. BENN, Director and Publisher

SIDNEY GRAVES KOON, Editor

Branch Offices { Philadelphia, Machinery Dept., The Bourse, S. W. Anness.
Boston, 170 Summer St., S. I. Carpenter.

Entered at New York Post Office as second-class matter.

The edition of this issue comprises 6,000 copies. We have no free list and accept no return copies.

Notice to Advertisers.

Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 5th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 1st of the month.

Attack on the Florida.

On May 27, the American single-turret monitor *Florida* was attacked by her sister ship *Arkansas*, one 12-inch shell, filled with high explosive, being directed against the face of the turret, close to the starboard gun, while one 12-inch and four 4-inch shells were fired at an experimental mast, built up completely of spirally-placed steel tubes to a height of about 90 feet.

The object of the attack was to determine the effect of the detonation of a high explosive shell against a modern turret, as regards both penetration and the disturbance of electrical and other fittings within the turret. The second part of the attack was intended to determine the value for fire-control purposes of such a mast as was fitted to the *Florida* for this purpose. In neither case was the attack or its object at all similar to those carried out by the British Admiralty against the old ironclads *Belleisle* and *Hero*, in which cases the object appears to have been to riddle the ships and effect a complete destruction. The attack differed in another way, in that the two British ships were condemned and of no further use, while the *Florida* is still serviceable as a coast-defense vessel, having in fact been launched as recently as 1900.

While the detailed results have not been made public, enough is known for us to state that after the attack on the turret, the turret turning, gun elevating and ammunition hoist mechanism was still in perfect order, and readily responded when called upon to function. The attack on the mast resulted in severing several of the tubes of which it was built, but such was the strength of the entire structure and its stability against failure, even in such a wounded condition, that it was still perfectly serviceable, and could have withstood apparently a much more severe fire than that to which it was subjected.

It is proposed to make a further experiment by mooring the *Florida* in shallow water and directing against her side a modern torpedo. The object of this is to determine to what extent inner subdivision may resist the explosion of such a torpedo, special compartments having been built into the ship for this purpose.

Marine Engine Design.

In this issue is being started a serial on the above topic which, it is expected, will run throughout the balance of the calendar year. The intention is to republish this in book form as soon as the serial is concluded.

Most of the text-books on the subject of marine engines deal only in a general way with the subject of design, and particularly with this subject as referring to the numerous co-ordinating parts of the modern marine engine. No matter how extensive the work, nearly all of the space is taken up with descriptions and illustrations of engines of various types, with some regard to historical features, but with very little to the actual work of laying out and designing the engine. It is felt that the little work at present under way will fill a decided void in this respect, and, being totally free from the descriptive part of the subject, which may be obtained in any text-book now on the market, it will be much more readily available for the particular use for which it is intended.

It is not the idea in this work to cover in detail the design of every part of the engine; but enough is given in the way of detailed design of the principal parts to indicate the general scope of the problem, and to lay down methods by which the entire work can be carried to completion. As given, this represents the result of several years of experience in teaching the subject of marine engine design to students of the University of Michigan. Irrelative material has been carefully excluded, and the whole subject is given in a concise and thoroughly readable manner.

Boilers and auxiliary machinery have been omitted

completely: the former forming a separate subject, and, indeed, under the present increasing steam pressures, we find that special watertube boilers are rapidly taking the place of their firetube predecessors, and these watertube boilers, being constructed by various manufacturers under their own patents, would scarcely form a fruitful subject for the discussion here of design. Auxiliary machinery is also largely in the hands of builders of special types, and comes under the same general classification with regard to the desirability of attempting to design it in a work of this sort. The propelling machinery alone is considered, but this is given in such detail as to make a fairly complete, though very brief, treatise.

Propeller Wheels.

Two articles this month deal with the ever-vexing subject of the propeller. One of them, from the pen of a practical marine engineer, discusses the laying out of propeller wheels, and is to be followed next month by a treatment of the making of patterns for propellers. The other article is the reprint of a paper read by an expert investigator before the Institution of Naval Architects, and is also to be concluded next month.

We have frequently had occasion to refer to this subject editorially, usually in connection with some article or series of articles which we were publishing. It is one of the utmost importance, and one to which, in most quarters, too little attention is paid. More than this, it is a subject which is perhaps as far from being an exact science as anything in modern shipbuilding. No two designers could be expected to turn out identical propellers from a given set of conditions and requirements; and frequently of half a dozen dissimilar designs, actual trials would have to be made to determine which was best suited for the purpose in hand. This arises from the fact that different features connected with the design of a propeller are differently evaluated by the various designers, and that the subject, so far as the laying down of specific rules for design is concerned, is still in a very unfinished state. It is for this reason that every bit of new information which can be brought to bear is of value, whether that information be the result of the trials of actual propellers on ships for which they were designed, or the result of experiments conducted with model propellers, either with or without an attendent hull.

For obvious reasons it is usually impracticable to run a model propeller in connection with a hull. In the first place, the models are usually run in a series, showing variation along one or more of their component elements, such as pitch, blade area, etc., and it would be practically out of the question to furnish hulls in sufficient number and variety to fit each of these separate cases. In addition to this, to make a complete test with the propeller accompanied by the hull, it would be necessary to arrange for both single and twin screws, and, indeed, if the practice is to apply to our latest turbine-driven ships, three and four screws would also have to be provided for. Not only this, but variation would necessarily be required with regard to the clearance between the tip of the revolving propeller blade and the hull, and, in the case of the single-screw ship particularly, the location in a fore-and-aft direction would introduce still another element of variation.

For this reason, nearly all of our available material in the shape of accumulated data from propeller experiments has been acquired through the running of propellers in free and undisturbed water, without any reference to the presence or absence of any hull or other structure. There has, of course, necessarily been such other structure present, but it is always located behind the propeller, and in such a position as not to affect the operation of the latter. This structure is required for the proper housing of that part of the mechanism designed to rotate the propeller.

Because of this divorcing of the propeller and the hull which it has to propel, these model experiments have been condemned in some quarters as totally unreliable. It cannot for a moment be claimed that the results of such an experiment would be the same without the hull as with it. Experience has shown, however, that for determining and delineating the action of the propeller, pure and simple, model experiments are not only trustworthy, but of very great value.

Perhaps the most notable instance of the application to practical use of the experimental model propeller occurred in connection with the building of the first vessel ever propelled by a steam turbine. This was the *Turbinia*, built in 1894. Originally this vessel was fitted with one large propeller. Instead of the high speed hopefully anticipated, only about half the ultimate speed was developed with this propeller. This means that the useful work done by the propeller was perhaps not more than 10 percent of that ultimately obtained by the fitting of the propellers with which the vessel made her first phenomenal burst of speed. Small propellers on three shafts were afterwards fitted, but there was an unaccountable loss of power between the boiler and the propulsion of the ship. Investigation by means of model propellers showed very clearly that this loss was due very largely to a phenomenon not unknown at that time, but much better known since, and which is called cavitation. It has been observed in many instances in connection with the operation at very high speeds of revolution of propellers designed for the absorption of considerable power. The studies which Mr. Parsons undertook at this time, added to those made by Mr. Barnaby, led to a complete change in the policy of fitting propellers for high-speed vessels; with the result that speeds of 30 knots and upwards are now attained regularly, and with little difficulty, by vessels of varying types and sizes, and with propellers so designed as to minimize the ill effects of this phenomenon.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

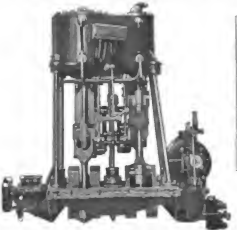
	Tons.	Knots.		April 1.	May 1.
BATTLESHIPS.					
South Carolina..	16,000	18½	Wm. Cramp & Sons..........	42.2	45.9
Michigan.......	16,000	18½	New York Shipbuilding Co....	48.6	50.7
Delaware.......	20,000	21	Newport News S. B. & D. D. Co	18.1	22.8
North Dakota...	20,000	21	Fore River Shipbuilding Co....	25.7	31.6
ARMORED CRUISER.					
Montana.......	14,500	22	Newport News Co...........	97.	98
SCOUT CRUISER.					
Salem..........	3,750	24	Fore River Shipbuilding Co...	95.2	96.4
TORPEDO BOAT DESTROYERS.					
Number 17.....	700	28	Wm. Cramp & Sons..........	12	15.9
Number 18.....	700	28	Wm. Cramp & Sons..........	10.8	15.4
Number 19	700	28	New York Shipbuilding Co....	11.5	16.2
Number 20	700	28	Bath Iron Works............	8	9.7
Number 21	700	28	Bath Iron Works............	7.8	9.3
SUBMARINE TORPEDO BOATS.					
Cuttlefish......	—	—	Fore River Shipbuilding Co....	99.	99.
Number 13	—	—	Fore River Shipbuilding Co....	30.	40.5
Number 14.....	—	—	Fore River Shipbuilding Co...	30	39.9
Number 15.....	—	—	Fore River Shipbuilding Co....	30.1	34.
Number 16	—	—	Fore River Shipbuilding Co..	29.9	34.2
Number 17....	—	—	Fore River Shipbuilding Co....	10.3	13.6
Number 18.....	—	—	Fore River Shipbuilding Co..	10.3	13.4
Number 19	—	—	Fore River Shipbuilding Co..	10.3	13.

ENGINEERING SPECIALTIES.

The Savery Steam-Yacht Engine.

The engine illustrated was fitted by T. A. Savery & Company, Newcomen Works, Birmingham, into a fast passenger launch for use on the Nile. The launch has a length of 40 feet, a beam of 8 feet, a draft of 2 feet 9 inches, and a speed, loaded, of about 12 miles per hour.

The engine is a quick-running compound of 38 indicated horsepower, with cylinders 4 and 8 inches diameter by 5 inches stroke. It operates at 620 revolutions per minute under a steam pressure of 250 pounds, and is fitted with an outboard or keel condenser. Steam is supplied from a quick-steaming watertube boiler fired with petroleum fuel, in which steam can be raised in a few minutes from cold water.



The weight of the machinery outfit complete, with stern gear, pipes, etc., is only 2,100 pounds, while the over-all length is just under 6 feet 3 inches. On account of the high rate of revolution, the air and feed pumps, which are worked off the main engine, are geared down to a reduced speed to insure efficient and silent operation.

Particular attention has been paid to the balance of moving parts, especially in the valve gear and connecting rods. There is a noticeable absence of vibration and smooth turning effort. The Joy valve gear is used, while all glands and bearings are of ample size and length.

A Small Speed Counter.

There has always been a demand for a small vest pocket speed counter which is accurate and durable. The speed counter here illustrated is one that is said to contain these qualities. It is of the same size as the illustration, being not quite 3 inches in length. While it is very small and convenient to carry it is by no means fragile. It registers the exact number of revolutions, requiring only the taking of the initial reading, and subtracting it from the final reading, to obtain the number of revolutions in time elapsed.

This unique speed counter has been placed on the market by the American Steam Gauge & Valve Manufacturing Company, 206 Camden street, Boston, Mass.

A Pipe-Bending Machine.

The photograph illustrates one of the latest types of pipe bending machines made by Henry Berry & Company, Ltd., Croydon Works, Hunslet, Leeds. This machine is designed principally for the purpose of bending steel and copper pipes, and is invaluable in marine engineering shops, where a large amount of this class of work has to be done.

The machine is fitted with two adjustable sliding blocks carrying rollers or bollards. These blocks are adjustable by means of screws, worked independently from either side, so that unequal sided bends can be made. The head is fixed on the hydraulic cylinder, which, having a long travel, can pass right through the adjustable sliding blocks for bending U or expansion joints.

The principal advantage claimed for this machine is that the obstructions on the top of the frame are reduced to a minimum, and so interfere as little as possible with the work being done. By the use of suitable blocks, angles, bars, channels and joists can be either bent or straightened.

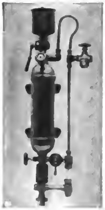
The machine illustrated has a power of 45 tons, and is capable of bending pipes up to 6 inches diameter. It was supplied to the order of the Admiralty for the workshop on Portland breakwater.

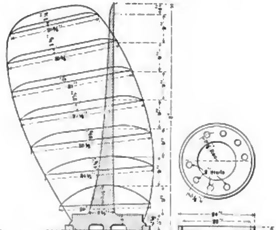
An Automatic Sight-Feeding Meter.

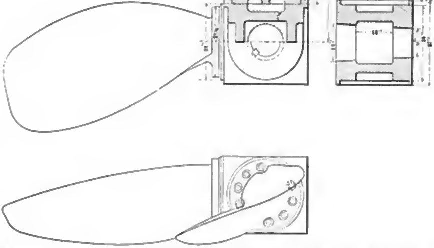
The "Boilerine" sight-feeding meter is placed on the market by the Boilerine Manufacturing Company, London, S. E., for the purpose of limiting incrustation in a boiler, thereby prolonging its life, reducing the expense of up-keep and saving fuel. A gunmetal casting with hemispherical ends, tested to 500 pounds per square inch, is fitted with a valve and an indicator fixed to the valve body, and a pointer by means of

which the operator can adjust the delivery to any desired speed.

The meter feeds the Boilerine boiler fluid direct into the boilers drop by drop, independently of the feed pump, and is so arranged that the quantity of fluid passing is always visible, this method guaranteeing the reagent mixing continuously with the feed water. The liquid, passing into and mixing with the water in the boiler, produces by chemico-physical action a loose non-adhesive granular deposit, which is easy of removal by means of a blow-off cock. Each meter carries a day's supply for the boiler for which intended, and they are made in sizes up to an evaporation of 16,000 pounds per hour.







A Successful Type of Propeller.

The propeller illustrated was built by H. G. Trout, King Iron Works Buffalo, N. Y., and is four-bladed, with detachable blades and adjustable pitch. The diameter is 14 feet; the pitch, as designed, 17 feet; the developed area, 64 square feet, and the disk area, 154 square feet. The ratio of disk to developed area is 2.4 to 1.

This is one of a series of propellers built by the Trout Works, the wheels being made from stock patterns, over 400 in number, for all sizes from 1 to 15 feet in diameter for solid wheels, and more than seventy patterns from 3 to 15 feet in sectional wheels.

Thor Close-Quarter Pneumatic Drill.

The Independent Pneumatic Tool Company, of Chicago and New York, has just placed on the market a close-quarter piston air drill, the dimensions of which are as follows:

	Inches.
Throttle connection to outside of spindle case........	15⅜
Point of feed screw to end of socket................	8⅞
Radius from center of feed screw to outside of case..	1 9/32
Width of case at cylinder flanges....................	5 3/16
Width at spindle....................................	6¼

Weight, 31 pounds; speed, 122 revolutions per minute.

The spindle is at one extreme end of the tool, and the motor is at the opposite end. The motor consists of two cylinders parallel with each other, and at right angle to the spindle, the center line of both cylinders centering on the center of spindle. The pistons are double acting, and operate on a two-throw crank. Between the crank throws at the center are located the eccentrics, the cranks and eccentrics being one forging. The eccentric straps operate directly on balanced cylindrical piston valves, having a reciprocating motion. The air is taken in centrally between the cylinders, and the valves control the air as close to the cylinder bore as

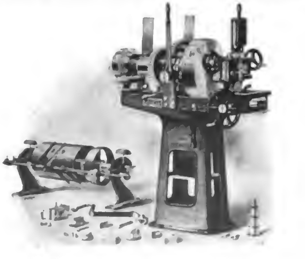
material will permit. The engine crank proper is not on the usual 90-degree angle, but has an angle of 135 degrees, thus allowing two pistons to pull when the position of levers requires the greatest power. This makes the drill in a degree self-regulating, and tends to still further govern the speed of the entire revolution of drill spindle. This drill is provided with reversible ratchet feed mechanism, operated within the width of the body of the drill itself. A poppet valve throttle controls the speed and power to a nicety, and also acts as a handle.

A New Pipe Machine.

This machine is placed on the market by the Crane Company, Chicago, to meet the demand for a low-priced machine, operated by hand or power, for high-class service. All parts have been designed to withstand any strains that such a pipe cutting and threading machine may be subjected to. Simplicity of operation, adjustment and arrangement has been carried out to the minutest detail.

This tool possesses many features which increase output and facilitate ease of operation. The gripping, threading, cutting-off and adjustment have been so arranged that no unnecessary operations are required. The frame is one casting, having bed and stand in one piece, eliminating the use of light legs, and giving greatest rigidity with minimum weight and floor space.

The die head is bolted to a movable carriage, with ample travel. Upon the die head are the dies, pipe guides and cutting-off tool. The dies are of the improved adjustable type, made collapsible. They are carried in suitable frames, sliding in guides, and moved by a screw operated by a hand wheel. They are set to gage by a simple locking device, which allows any number of pieces of pipe of the same size to be threaded without any further adjustment. These dies have four cutting



edges, and will give good service on either steel or wrought iron pipe. Dies are made interchangeable, and one die of a set may be replaced if broken, thus reducing the repair bill to the minimum.

When cutting off, the pipe is guided by two steel guides, hardened on the face. These guides are operated by a right and left screw and hand wheel. The cutting-off tool is operated by a lever and rack. This makes a rapid, simple and positive device and extremely powerful. The gripping chuck is of the quick gripping type, rapid in action and very powerful. Pipe may be released and gripped by the throwing of a lever without stopping the machine. The chuck is adjustable to the different sizes of pipe within range of the machine, without moving or altering the jaws. The jaws are of tool steel carried in steel holders, and are removable for grinding or replacing.

The capacity is from ¼-inch to 2-inch pipe. The dimensions of the countershaft pulley, running at 200 revolutions per minute are 9¼ inches diameter by 3½ inches face. The floor space required is 44 by 23 inches; the weight, 700 pounds.

The *Mauretania* recently made 635 nautical miles in one day's steaming westward. The *Lusitania* promptly answered with 641.

TECHNICAL PUBLICATIONS.

Warships: A Text-Book on the Construction, Protection, Stability, Turning, Etc., of Warships. By Edward L. Attwood, M. I. N. A. Size, 6 by 8¾ inches. Pages, 316. Figures, 230. London and New York, 1908: Longmans, Green & Company. Price, 10/6 net and $3.00 net.

This is the third edition of a work first issued in 1904, intended primarily for the use of naval officers, and as a text book covering the designing of the principal features of construction of warships. It is divided into twenty-four chapters and two appendices, followed by an index, and takes up in rotation the strength of ships, tests of steel, sections, rivets and joints, the framing of various types of ships, beams, pillars and decks, plating of the outer and inner bottoms, watertight bulkheads and doors, stems, sternposts, rudders, shaft brackets and steering gears, pumping, flooding, drainage and ventilation, corrosion and fouling, coaling, armoring and deck protection, mensuration rules, navy list displacement and tonnage, buoyancy, tons per inch, stability, trim and stability at large angles of inclination, the rolling and turning of ships, the resistance and propulsion of ships, the design of warships and notes on the loss of H. M. S. *Victoria*.

The work is eminently practical, and gives details of the structural arrangements of most of the principal types of battleships and large cruisers in the British navy up to the *King Edward VII.* and *Lord Nelson* classes. The arrangement of armor is shown, with the forms of backing of wood, and the framework upon which the armor rests. The chapter on the design of warships is quite general, outlining the method of procedure in designing such vessels, and giving in some cases distributions of weights. Notable in this connection are the weights given of five Japanese war vessels, the battleship *Asahi*, the armored cruiser *Asama*, the cruisers *Takasago* and *Akashi*, and the destroyer *Akutsuki*, as well as that of a small cruiser of 2,650 tons, belonging to the British navy. The first appendix consists of a large number of questions under each chapter, with answers thereto. The second appendix is a memorandum of the main elements of the *Dreadnought* and *Invincible* designs, presented to Parliament in 1906.

While it would be impossible in the scope allowed by 300 pages to even outline the designing of an entire warship, the principal features are taken care of in this book in such a manner as to cover the main points of construction of the hull and its general fittings. No attempt is made to go into engine or propeller design, nor are the military features, aside from the armoring of the hull and barbettes, given any attention whatsoever. The distribution of guns and their protection are left for the designer to figure out for himself, the work being, in fact, concerned simply with the hull design of warships in general and of battleships and large cruisers in particular.

Night Signals of the World's Shipping. By D. H. Bernard. Size, 5½ by 8½ inches. Pages, 127. Numerous illustrations in colors. Glasgow, 1908: James Brown & Son. Price, 7/6 ($1.75 net).

This book is a compilation of the night signals of the various steamship lines and yacht clubs, and is intended to be such an aid to the officer on watch as to enable him to recognize at once a vessel's signal, thus avoiding much delay and confusion. By previous methods it has been necessary to turn over many pages of printed details before finding a signal, whereas in the present case the colors are arranged in order, and in such a manner as to be readily accessible.

The work is divided into eleven sections, the first five of which are devoted to pyrotechnic and other lights under the several headings of blue, green, red, white and yellow, each color mentioned being the predominant one of the signal. The other sections include rocket displays; roman candle displays, separate and accompanied by other lights; sound signals, with or without lights; guns, and Lloyd's signal. Blank

spaces are left throughout the book for additional signals to be noted, although the number given is very great and covers practically all that would be necessary in most cases.

Structural Engineering. By Prof. A. W. Brightmore, D. Sc., M. I. C. E. Size, 5½ by 8⅜ inches. Pages, 280. Figures, 145. London, E. C. (La Belle Sauvage), and New York, 1908: Cassell & Company. Price, 10/6 net and $3.75 net.

This work is designed to fill the need for a text-book suitable for students of engineering, and placed intermediate between the subject of strength of materials and such specialized works as bridge construction, etc. With this idea in view, the endeavor has been to treat in a consecutive and intelligible manner the principal ideas and methods underlying the investigations necessary in the designing of structures. The historical side has been omitted, but certain aspects of the subject, such as the methods of construction and the use of the equilibrium polygon and the stress ellipse, have been given rather more prominence than is usual in works of this sort.

It is recognized that in most engineering problems it is not possible to make hypothetical assumptions and convert them into mathematical equations. As a result, mathematics have generally to be applied in detail to each part of a problem, and the assumptions readjusted at each step, to prevent the mathematical deductions from diverging to any considerable extent from actual conditions. The success of the design of any engineering structure depends largely upon the judgment of the engineer, based on a knowledge of the fundamental principles of statics.

The work is divided into fifteen chapters, followed by an index, and is devoted mainly to the design of girders, bridges and arches, together with retaining walls, foundations, dams and structures of reinforced concrete. The illustrations are all of the line type, and are sufficiently clear for the purpose intended. The typography is very good.

Machine Design, Construction and Drawing. By Henry J. Spooner, C. E.; professor of mechanical and civil engineering in the London Polytechnic School of Engineering. Size, 5⅛ by 8½ inches. Pages, 691. Figures, 1,424. London and New York, 1908: Longmans, Green & Company. Price, 10/6 net and $3.00 net.

This is a text-book for the use of students and young engineers, and in it the work is carried through in regular rotation, beginning with a description of drawing instruments and their uses and various methods for testing them.

The first five chapters are devoted to these elementary considerations, after which are taken up stuffing boxes, collars, shafting, cranks, journals, couplings and clutches, keys and pins, riveted joints, bolts, nuts and screws, pipes and connections, cotters, knuckle joints, bearings and hangers, roller and ball bearings, toothed and friction gearing, belts, rope and wire rope gearing, chains, crane hooks, tanks, pistons and rods, crossheads, guides and crank rods, eccentrics, springs, and two large chapters devoted to miscellaneous items, such as materials used in construction, strength of beams, drop forgings, data regarding pumps, etc., etc.

The work is very profusely illustrated with sketches and occasional half-tones, and is well fitted out with tables giving proportionate parts and constants for working. Examples are given for examinations, and the whole work is so arranged as to be readily applicable for use as a text-book. Many exercises, especially at the ends of chapters, are provided with answers where such can be expressed in figures. Much of the information used has been drawn from the technical press of England and America, as well as some works from the continent of Europe.

Equipment Buyers' Finance: The Effect of Speeds on Profits. By Arthur Winder. Size, 8½ by 11¼ inches. Pages, 16. Leeds, 1908: Electric Printing Works. Price, 1s. net.

This is a brief discussion in five chapters of the subject of machine tools as affected by the type used and the speed of operation. The subject of using an old lathe of low first cost, as compared with a high-speed lathe of higher cost, is taken up, and the latter is shown to be more economical when it comes to comparing output with cost.

QUERIES AND ANSWERS.

Questions concerning marine engineering will be answered by the Editor in this column. Each communication must bear the name and address of the writer.

Q. 407.—In a triple-expansion engine with cylinders 20, 36 and 57 inches in diameter by 24 inches stroke, the revolutions per minute are 150, the steam pressure, 165 pounds gage; the cut-off in high-pressure cylinder occurs at three-fourths stroke, the clearance is 10 percent. A single feed pump of the plunger pattern is connected to the engine, and has a stroke of 10 inches. What should be the plunger diameter?

2.—How many times the theoretical quantity of water would you decide on for the capacity of the pump? P. G.

A.—1. The formula commonly used in designing feed-pump plungers is:

$$D = \sqrt{\frac{550 \times Q}{N \times L}}$$

where D is the diameter of the plunger in inches; L is the stroke in feet; N is the number of working strokes per minute, and Q is the quantity of feed water in cubic feet per minute. On this basis

$$D = \sqrt{\frac{550 \times 2.13}{150 \times 0.83}} = \sqrt{9.372} = 3.06 \text{ inches.}$$

This calls for an area of plunger of 7.35 square inches.

The above computation was made on two assumptions. In the first place, the indicated horsepower of the engine was assumed, from the data given, to be 500; in the second place, the consumption of steam per horsepower-hour was assumed to be 16 pounds. This gives 8,000 pounds of steam per hour, or 133 pounds per minute, which amounts to 2.13 cubic feet per minute. The number of working strokes of the pump is, of course, the number of revolutions of the engine per minute, because the pump, being of the plunger type, is single acting.

2. The displacement of a plunger of the area and stroke given is 0.0425 cubic foot per stroke, or 6.375 cubic feet per minute. This is 398 pounds per minute of water, theoretically. It will be noticed that this is almost exactly three times the required amount of water for the engine, which is explained in two ways. In the first place, it is customary to fit a feed pump of twice the required capacity, in order to be able when necessary to fill the boiler rapidly. In the second place, leakages in the pump and the necessity for making up a certain amount of loss of feed, due to leakages in the engines and connections and to the occasional use of steam for whistling, require that the plunger displacement be considerably greater than the theoretical figure. These two considerations have operated to make the plunger area about three times the size theoretically called for.

Q. 409.—How may the number of gallons of water discharged from an orifice in a given time be computed, when the pressure of the water and the size of orifice are known?

2.—Is there a formula giving the ratio of water pressure to the velocity of the water? D. F. B. L.

A.—The formula is

$$Q = C \sqrt{2gH} \times A.$$

in which Q is the number of cubic feet per second; g is the gravitation factor, or 32.16 feet (per second)^2; H is the head of water measured in a vertical line between the center of the orifice and the level of still water above it; A is the area of the orifice in square feet. The factor C, which is almost universally taken as 0.62, takes account of the fact that water, in flowing through an orifice, has a tendency to take on a

contracted cross-sectional area, due in large measure to the friction against the sides of the orifice. To reduce the quantity to gallons the number of cubic feet would be multiplied by 7.84 (for imperial gallons, multiply instead by 6.24). The velocity of the water is represented by the expression $\sqrt{2gH}$. The static pressure at center of orifice is H.

To take a concrete example, suppose we have a square orifice measuring 2 feet on the side, and with its center 4 feet below the surface of still water. Then

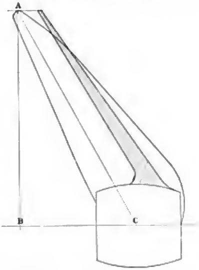
$$Q = 0.62 \sqrt{2g \times 4} \times 4 = 40 \text{ cubic feet per second.}$$

This represents about 300 United States gallons, or 250 British imperial gallons, per second. The velocity is 16 feet per second. The mean static head is 4 feet or a pressure of 1¾ pounds per square inch.

Q. 408.—How can I find the area of a propeller blade while the ship is in drydock?

2.—Having a blade with an excessive droop astern, will the diameter be equal to twice the radius on line *A B*, or on line *A C*? JUNIOR.

A.—1. We assume that the developed area is what is wanted. By drawing a straight line down through as nearly as possible the center of the blade from hub to tip, and setting off perpendiculars from this line at known distances apart, the lengths of these perpendiculars can be spaced off with dividers and set down on a drawing. The developed area of the blade may thus be traced in through the outer ends of these lines, and the area obtained either by means of a planimeter or by some process of approximate integration. For the latter it would be necessary to have the perpendiculars equally spaced from root to tip. In this case *the summation of all the lengths, added to one-twelfth the sum of the second and the next to last, and diminished by seven-twelfths of the two end ordinates*, would give a factor which, multiplied by the distance between ordinates or perpendiculars, would give the



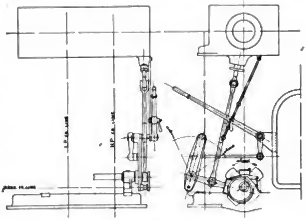
desired result. This would not include the approximately triangular sections between the perpendicular at the root of the blade and the root itself as it follows the contour of the hub. For practical purposes, however, the area in this section of the propeller is of very little value, particularly as regards thrust, and for computations. If it were desired, however, an approximation sufficiently close for the purpose could easily be made.

The natural way to take ordinates of this sort would be, not along a perpendicular to the center line, but along arcs of concentric circles, of which the common center is the center of the propeller shaft. For the case in question, however, this might not be feasible and the method above outlined will give the result equally well.

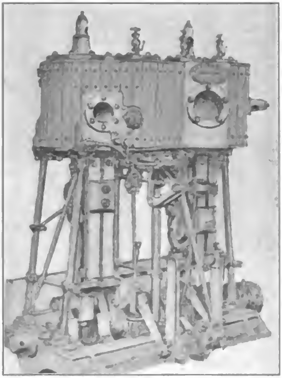
2. The diameter would be twice the radius *A B*. The diameter of a propeller wheel is defined as the diameter of the circle swept by the tips of the blades while in rotation.

Q. 406.—On page 94, in your February number, in describing a small steam-yacht engine, built by W. Sisson & Company, Ltd., Gloucester, you state that the valve gear is of their specially designed, single fixed eccentric or elliptic type. Please give an outline sketch and the name of this gear. K. I.

A.—The sketch shows the arrangement of the gear as fitted



to a compound surface-condensing engine, with cylinders 9 and 15 inches in diameter and 10 inches stroke. This gear is Messrs. Sisson's modification of what has been commonly known as the Marshall valve gear, which itself was a modifi-



cation of the original Hackworth gear. The latter had a slide, the angle of which could be varied in relation to the crank shaft, while the Marshall or elliptic valve gear has a swing link. The inclination of the path of the eccentric lever end is varied by moving the weigh shaft in or out, thus giving the necessary obliquity and the elliptic movement to the lower end of the intermediate valve rod.

Personal.—By an act approved April 16, concerning the revenue cutter service of the United States, the ranking officer of the engineer corps (Chief Engineer Charles A. McAllister) is continued as engineer-in-chief, with a rank raised from that corresponding to captain in the army to that of lieutenant-colonel. Under the same act the commandant of the service (Captain Worth G. Ross) is raised in rank to that corresponding to colonel in the army or captain in the navy.

William T. Donnelly, consulting engineer, has moved from 132 Nassau street to 135 Broadway, New York.

Frederick D. Herbert, formerly editor of this journal, is in charge of the New York office of the Terry Steam Turbine Company, at 90 West street.

Obituary.

Rear Admiral Charles W. Rae, engineer-in-chief of the United States navy, and chief of the Bureau of Steam Engineering of the Navy Department, died in Washington, May 13. He was born in Hartford, Conn., in 1847, and was graduated from the Naval Academy in 1868. He was appointed engineer-in-chief and chief of the bureau on Aug. 3, 1903, for a term of four years, which was renewed last August for a similar period. He has been succeeded by Captain John K. Barton, who becomes engineer-in-chief, and head of the bureau.

Samuel Samuels, skipper of the *Henrietta*, which won the first transatlantic yacht race, and for nine years captain of the famous clipper *Dreadnought*, died May 18. With the *Dreadnought*, in 1859, he made a record across the Atlantic from England to New York of 9 days 17 hours, actually beating by some 24 hours the steamship records of those days. He was president of the *Marine Journal* Company, in which office he has now been succeeded by the editor, Capt. George L. Norton.

Francis B. Stevens died in Hoboken May 23 at the age of 93. He was a civil and mechanical engineer of great note during the first half of the nineteenth century, his best known invention being the Stevens cut-off, first applied to the steamboat *Albany* in 1840, and in use on practically all side-wheel steamers of the present day. He was prominently identified with the introduction of railroads into the United States.

A. S. Crowninshield, rear admiral, U. S. N., died in Philadelphia, May 27, at the age of 65. He was a graduate of the Naval Academy at Annapolis, and saw service in the civil war. During the Spanish war, and for some years thereafter, he was chief of the Bureau of Navigation in the Navy Department, and was a member of the Naval War Board.

SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

881,803.—PROPULSION OF SUBMARINE BOATS. GEORGE F. JAUBERT, PARIS, FRANCE.

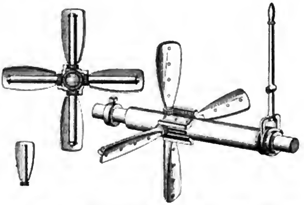
Abstract.—According to this invention, an explosion gas engine is fed in a closed cycle; *i. e.*, without air being utilized for the combustion of the fuel. The combustion gases exhaust into a purifier or washer, where the steam is condensed and the carbonic acid partly absorbed, so that an inert gas is obtained, which is then mixed with oxygen and is capable of being again utilized in the engine for producing an explosive mixture with the liquid fuel. Five claims.

884,936. APPLIANCE FOR ADDING TO THE RECORD SPEED OF VESSELS. WILLIAM LAUDAHN, LOS ANGELES, CAL.

Abstract.—The invention relates to a system of pipe or other conduits which are placed upon the exterior of the submerged portion of the hull, said pipes leading from a tank or reservoir placed within the hold of the vessel. The tank or reservoir contains an oil, emulsion or like liquid having little affinity for water. The oil, etc., by means of the apparatus, is ejected in minute quantities and distributed to the submerged portion of the hull, thereby materially reducing the friction, in addition to preventing the hull from fouling. Two claims.

881,775. SCREW PROPELLER. ROSCOE E. COON, PORTLAND, OREGON.

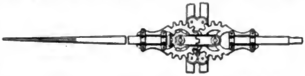
Claim 2.—The combination of a propeller shaft having rigid right



angular arms, propeller blades with sockets and gear wheels on the inner ends of the same mounted to turn on said arms, an outer sleeve inclosing the propeller shaft and having longitudinal slots to give passage to said arms, rack bars arranged beside the slots and fixed to said sleeve, means for sliding said sleeve longitudinally over the propeller shaft to adjust or reverse the pitch of the propeller blades, and stops for limiting the throw of the blades. Three claims.

882,072.—OAR. JOSHUA LEHMAN, TORONTO, CANADA.

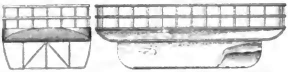
Claim 1.—In an oar, in combination, a pivotal block supported from the gunwale of a boat and having pins extending upwardly from each end thereof, a pair of co-acting segmental toothed gears journaled on said pins, an oar handle rotatably supported from one of said gears, an oar stem rotatably supported from the other of said gears, a bevel pinion fixedly secured to the inner end of said oar stem and rotating



therewith, and a plate having orifices therethrough, through which pass the pins extending from the pivotal block, said plate being rigidly secured to the pins above the segmental gears, and having a bevel gear surface formed on its under side at one end, and meshing with the bevel pinion secured to said oar stem, and adapted to rotate said pinion on the swinging of the segmental gear supporting said oar stem, to feather the oar.—Three claims.

882,194.—BOAT. JOHN W. GAY, RICKREALL, OREGON.

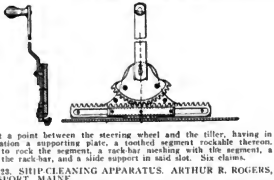
Abstract.—The boat consists essentially of an air chamber upon which its floating capacity depends. The top of this air chamber, being always above the waterline, constitutes the main deck of the vessel.



Above this main deck are other decks, having either open or inclosed sides, as may be necessary. Below the air chamber, the boat is formed with longitudinal compartments of special construction arranged for the free longitudinal passage of water through them, but at the same time acting as ballast means to prevent a tipping of the boat. Four claims.

882,821.—STEERING DEVICE FOR POWER BOATS. JAMES A. GARRETT, AUBURN, N. Y.

Claim 4.—In a power boat having a steering wheel, a tiller and a tiller rope, a supplemental steering mechanism connected to the tiller



rope at a point between the steering wheel and the tiller, having in combination a supporting plate, a toothed segment rockable thereon, means to rock the segment, a rack-bar meshing with the segment, a slot in the rack-bar, and a slide support in said slot. Six claims.

883,423. SHIP-CLEANING APPARATUS. ARTHUR R. ROGERS, JONESPORT, MAINE.

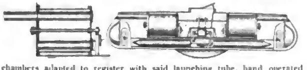
Claim 6.—The combination with a guiding frame constructed to engage the keel of a vessel, and ropes attached to said frame, of a series of revolving scrapers free at one end and connected at their other ends with the guiding frame. Nine claims.

883,588.—INVISIBLE AIR-CHAMBER AND SPONSON FOR CANOES. CALEB B. THATCHER, BANGOR, MAINE.

Claim.—A canoe having tapering curved ribs cut to conform to the curvature of the hull secured to the outside of the planking, and extending from the gunwales to the waterline, said ribs gradually decreasing in width and length from the center towards each end, planking secured on said ribs, and canvas secured over said hull and ribs, having its side edges secured under the gunwales of the canoe, forming an invisible airtight compartment. One claim.

883,664. TORPEDO BOAT, ERNST A. NILSEN, CHRISTIANIA, NORWAY, ASSIGNOR OF ONE-HALF TO BERNARD CRAFTON, CHICAGO.

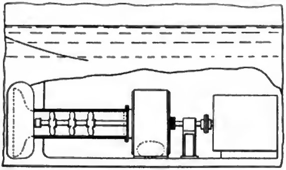
Claim 2.—In a torpedo boat, or submarine, the combination with a torpedo launching tube opening outwards through the hull of the boat, of a rotary magazine drum provided with a plurality of torpedo



chambers adapted to register with said launching tube, band operated means for rotating said drum, and hand operated means for releasing said torpedos from said chambers when desired, comprising a hand rod with a yoke pivoted thereto and adapted to bind against said torpedo when in its forward position, and to engage the starting arm of the torpedo when drawn rearward. Four claims.

884,079. PROPULSION OF SHIPS. EDWARD J. DUFF, LIVERPOOL.

Claim.—Means for propelling ships, comprising a prime mover, a centrifugal pump actuated thereby, a shaft therefor, a turbine mounted

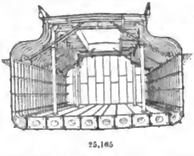


directly on said shaft and in the lower part of the boat, means connecting the turbine with the water outside the boat whereby the power which is in the head of water required to float the ship is utilized, said centrifugal pump adapted to eliminate the back pressure on the turbine, and capable of removing more water than is admitted by the turbine. One claim.

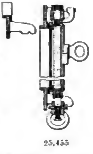
British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

25,165.—SHIPS' FRAMES AND FRAMING. C. D. DOXFORD, SUNDERLAND.

Turret vessels are fitted with vertical columns or supports arranged upon the line where the inswept frames turn upwards to form the turret. The columns are preferably of tubular construction, secured at their lower ends to the hollow bottom, and at their upper ends to the frames, by brackets or their equivalents. Light diagonal struts are also fitted, and extend from the frames to the beams. The struts are arranged in pairs, one on each side of each column. Deep frames strengthened by horizontal stringers are used in the ship's construction, if found necessary. In a modification, in which "'tween decks" are fitted, the columns are attached to such decks, and smaller columns are fitted between the decks and the beams.



25,165



25,455

25,455.—SHIPS' CABIN LIGHTS. J. BROADFOOT & SONS, WHITEINCH, and J. R. APPLEBY, PARTICK.

Relates to that type of ship's side scuttles in which the scuttle ring is pivoted in a block having side trunnions working in bearings in lugs on the scuttle frame. A stud is fitted in the scuttle ring, and has a square block mounted on its unscrewed part, which extends between lugs on the frame. In the edges of these lugs are two notches in which projections engage. The scuttle ring is held in its closed position by any convenient fastenings, and may be held slightly open by permitting the projection to engage the catch, the ring turning on trunnions. The trunnions are mounted in lugs having slots, so that the ring may be turned at right angles to the frame.

24,854. PROPELLING SHIPS AND BOATS. W. COCHRANE, LONDON, W.

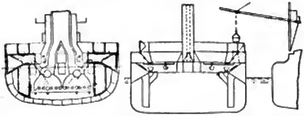
The propellers are of the vibrating-plate type and are arranged in pairs, operated by motors, the boat being fitted with two bilge keels. Each motor has a shaft, extending on opposite sides of the crank chamber, and provided with a clutch. A disk fixed obliquely to the shaft is grooved and carries on ball bearings a strap, to which is pivoted a fork on the vertical shaft of the propeller. The amplitude of oscillation of the propeller may be varied by altering the obliquity of the disk; to attain this object, the disk is pivoted to the end of the shaft, and is linked by a rod to a sliding collar, which is controlled by a pivoted lever or by means of worm gearing. To prevent wear of, and noise due to, the propeller, the vanes are beaded to engage a socket in the propeller frame, the end of the frame having an overhanging flange, so that the water is prevented by the flange from escaping, and acts as a buffer.

21,879. SHIPS' CABIN; BERTHS. A. H. BAIRD, LIVERPOOL.

Relates to the metal fittings by which the portable partitions of staterooms and berths for ships are secured to the upright posts forming the framework of such rooms and berths. To avoid the gap below the joint caused by the necessity for having a clearance space, the fitting is provided with a sliding piece. A hook engages a cup attached to the post, and the sliding piece fits closely against the cup and is there maintained in position. As the hook and the partition fall into place, relative movement takes place between the cross-plate of the fitting and the sliding piece. The flanges on the latter cover the gap which would otherwise be formed below the cup.

25,506.—WARSHIPS' BUNKERS. DUISBURGER MASCHINENBAU AKTIEN GESELLSCHAFT, FORMERLY BECHEM & KEETMAN, DUISBURG, GERMANY.

Coal is stored partly in hold bunkers and partly in lower-deck

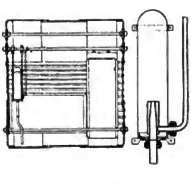


bunkers, and instead of the lower-deck bunkers acting as reserve bunkers to the hold bunkers, they are provided with shoots for discharging the coal directly into the stokehold, without passing it through the hold bunker. In one example, the lower-deck bunkers are divided longitudinally by a partition provided with doors, and are fitted with shafts for charging, which are closed by other doors. The hold bunkers are filled through shafts and doors, and are discharged into the stokehold by other doors. The lower-deck bunkers communicate directly with the stokehold by means of shoots. In a modification, the part of the deck and the side plating outboard of the shaft are hinged to one of the decks, and are moved to facilitate charging the various bunkers. Suspension truckways may be fitted in the lower-deck bunkers.

26,249.—SHIPS' STAIRCASES; VENTILATING. F. ALCOCK, BIRKENHEAD.

The stairs or ladders used to gain access to the various holds of a ship are disposed within a tube which extends through the decks. Openings and landings are provided at each deck, and sliding doors are fitted at convenient places. The tube may also be utilized as a ventilating pipe, and for that purpose is provided with a cowl at its upper end. The tube may be constructed of openwork, such as bars or gridwork, fixed between the decks.

26,249



26,967

26,967. STEAM GENERATORS. J. BRUNDRIT, LIVERPOOL.

Water-circulation, promoting.—The boiler is fitted internally with a closed vessel and connected by pipes with the steam space and the lower part of the water space. The air trapped in the vessel during the filling of the boiler expands when heated by the surrounding water, and drives out the water through a pipe. Water then enters the vessel through another pipe. The first pipe is connected with a casing surrounding the conical end of the latter pipe and open at the top and bottom. The vessel may be fitted in the smoke-box and may have cross-tubes; or it may be composed of tubes.

International Marine Engineering

AUGUST, 1908.

BRITAIN'S NEW TURBINE BATTLE CRUISER INDOMITABLE.

The new *Indomitable*, which has created a world-wide interest, has now passed through all her official steam and gun trials with the greatest success. During her 24-hour speed test she is said to have averaged the high speed of 26.75 knots, and at times actually reached 28 knots. The contract speed was 25 knots. Following out the conditions of secrecy which have been observed during the construction of this ship, it has not been considered advisable to give any particulars of the speed trials; but we can now deal more freely with the "ship of mystery" than was the case when we gave a description of the vessel in our issue of May, 1907, because she has now passed from the builder's closely-guarded private works to the open sea, where she is unable to be concealed from the keen, searching eye of the photographic camera. The *Indomitable* is the first completed of the three ships of the *Invincible* class, having been constructed in the record time of two years and two months. This gives some indication of the high standard attained in shipbuilding on the Clyde.

The main features of the ship were described last year, but one or two facts may be repeated here. The vessel is 530 feet long between perpendiculars (560 feet over all, this being the greatest length of any warship afloat or projected), with a breadth of 78 feet 6 inches, and displaces 17,250 tons, on a draft of 26 feet. Her side armor is 7 inches in thickness amidships, tapering to 4 inches at bow and stern. The gun barbettes are of 8-inch armor, while the turrets are of 7-inch armor.

We give reproductions of several photos of the ship, clearly illustrating her appearance and fighting power. It will be noted that our last description of the position and number of the main guns was correct. There are eight 12-inch guns, each of 45 calibres in length, firing an 850-pound shot, with a muzzle energy of 47,697-foot tons. The forward pair of 12-inch guns is on the forecastle deck, and the four amidship guns are on the same deck level, and situated between the second and third funnels, as shown in illustrations. The after pair of guns is on the upper deck, apparently about 9 feet lower than the forecastle deck. All the eight guns are arranged to fire on either broadside, and six guns may be fired ahead and a similar number astern, so that in gun power the *Indomitable* is equal to the battleship *Dreadnought*. The secondary armament consists of a large number (sixteen) of

THE CENTRAL PORTION—STARBOARD SIDE—OF THE BRITISH CRUISER-BATTLESHIP INDOMITABLE.

VIEW FROM OFF THE STARBOARD QUARTER OF THE CRUISER-BATTLESHIP INDOMITABLE.

4-inch guns, half of them mounted in pairs on the four turrets. This arrangement permits the training of twelve of these guns on either broadside.

To the outside observer the ship has many new features. A very noticeable detail is the arrangement of the masts. They are both of the tripod type; this entirely dispenses with the shrouds, which would have obstructed the training of some of the guns. Also, the tripod form reduces the possibility of the mast's being completely shot away, for even if one leg did go the others would stand, with temporary guy ropes. This is an important detail, because the masts carry the gun sighting ("fire control") stations and the receiving wires in connection with the wireless telegraph system. The customary gaff for the aerial wire has been dispensed with, and the masts have been increased in height so as to give an aerial wire arrangement between the masts in a manner similar to that adopted on the *Lusitania*.

Then there is almost an entire absence of boat davits, as most of the boats have been placed so that they may be put overboard with derricks. But the ship's lifeboats are very conspicuous, in long goose-neck davits, so arranged that the boat can be lowered over the ship's side or stowed inboard clear of gun fire. Another noticeable detail is the position of the compass platform, which is very high up, and appears to be almost level with the top of the funnel. The ship is also provided with torpedo-net defense, all fore and aft.

The propelling turbines are of the Parsons type, designed to give 41,000 horsepower, and are placed in two compartments, divided by a center-line bulkhead. They are similar to those in the *Dreadnought*. Thus, in each engine room there

THE CRUISER-BATTLESHIP INDOMITABLE HAS THE GREATEST LENGTH OF ANY WARSHIP AFLOAT.

are one high-pressure and one low-pressure main ahead turbine, a cruising turbine, and one high-pressure and one low-pressure astern turbine. The high-pressure ahead and the high-pressure astern drive the outer shafts, while the cruising and the low-pressure ahead and low-pressure astern are on the inner shafts. The four shafts have one propeller on each, and these turn outboard when going ahead. The two outer propellers are placed forward of the inner ones. The ship has two rudders of the balanced type, which are hung from the stern structure. They are similar to those in the *Dreadnought*, and, being of larger area, give the ship a great turning power.

MARINE ENGINE DESIGN.

BY EDWARD M. BRAGG, S. B.

STRENGTH OF MATERIALS.

The cylinder diameter and cut-offs having been determined, we are in a position to approximate to the loads coming upon the different parts, and to proportion them so that they shall be strong enough to carry these loads. There are a great many formulæ in use for this purpose, but many of them are in such shape that they cannot be readily adapted to all conditions. Most of them are based upon the assumption that steel of a certain ultimate strength is to be used, and that, therefore, the allowable working stress is a fixed quantity. Since, however, the ultimate strength of the steel used in marine engines varies from 60,000 pounds to 100,000 pounds per square inch, it is much better to base the calculations upon the allowable factor of safety, and that is the principle which will be followed in this system of design.

The factor of safety which it is allowable to use in the design of a given part depends upon the kind of load to which it is subjected, the construction of the part itself, and upon the conditions under which it works. There are three kinds of loads: steady loads, intermittent loads and alternating loads. The steady load is one which is applied originally in an appreciable length of time, and the stress resulting in either tension or compression of constant amount. The intermittent load is one which is applied more or less suddenly, and produces either tension or compression; the stress varying from zero to a maximum, or from a minimum to a maximum. The alternating load is of such a nature as to cause the stress to change alternately from tension to compression.

The elastic limit is the limit of the stress to which a material may be subjected, and have the strain or deformation proportional to the stress. The elastic limit is not the same under all conditions. When the steel comes from the mill, it may have an unnatural elastic limit, due to its treatment during manufacture. When subjected to a moderate alternating load for a short time, the effect of this treatment will be overcome, and the piece will have more nearly its natural elastic limit. The tension elastic limit may be increased by subjecting it to successively increasing loads, but its elastic limit in compression will be correspondingly decreased; so that a piece which has been subjected to large intermittent tension loads might fail at a comparatively small load in compression. The elastic limit in compression can be restored by subjecting the piece to successively increasing compression loads, the elastic limit in tension then being correspondingly decreased.

It has been found by experiment that a piece which would carry a constant total load of 80,000 pounds tension for an indefinite time, would fail after a while if the load were an intermittent one varying from 80,000 pounds to 40,000 pounds; it would fail sooner if the load varied from 80,000 pounds to zero; and would fail in a comparatively short time if subjected to an alternating load varying from 80,000 pounds in tension to 80,000 pounds in compression. In order to have the piece equally strong under each condition of loading, the maximum of 80,000 pounds constant load which the piece will carry indefinitely should be reduced to 40,000 pounds if the load is intermittent, and varies from 40,000 pounds to zero, and to something between 40,000 pounds and 80,000 pounds if the minimum is 30,000 pounds instead of zero. If the stress varies from tension to compression, the load should vary from not more than 27,000 pounds tension to 27,000 pounds compression, in order that the piece may last indefinitely. In other words, the destructiveness of the three kinds of loads, constant, intermittent and alternating, is about in the ratio of 1, 2, 3, respectively.

Experiment has shown that for steel the elastic limit is from one-half to two-thirds of the ultimate strength. It is customary to choose the working stress so that it shall be less than the elastic limit of the material, usually less than one-half of it. It results, therefore, that in some structural work on land, the factors of safety employed are 3, 6 and 9 for steady, intermittent and alternating loads.

The statement was made above that the conditions under which the parts work affect the factors of safety. The breaking

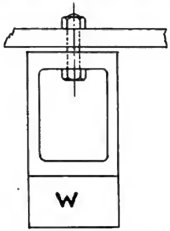


FIG. 4.

of the parts of an engine in a ship would be attended with so much danger, and the facilities for repair are so limited, that somewhat larger factors of safety should be employed for marine engines than for structural work on land. In this system of design, the factors of safety used for engines of the merchant marine are 4, 8 and 12 for steady, intermittent and alternating loads, respectively.

In engines for the vessels of the navy, the factors of safety employed are more nearly 3, 6 and 9. The reasons for this are that it is desirable to save weight, the life of the engine is comparatively short, and the engines are seldom run at full power. Naval vessels are usually cruising around at one-half or two-fifths power, so that although the factors of safety are smaller for full power, they are amply large for the reduced power which the engines develop during the greater part of their existence.

Practically there are no parts of a marine engine which can be designed for steady loads. Some of the bolts and threaded parts may be subjected to steady loads if the nuts are set up tight enough, but it would not be safe to count on the nuts always being as tight as when they were first set up. The stress in the body of a bolt is always that due to setting up the nut, unless the load upon the bolt is in excess of this. Referring to Fig. 4, it can be seen that the stress in the body of the bolt will be that due to the load W as long as the flanges are apart. When the nut is set up sufficiently to bring the flanges together the stress will be increased, and the body of

the bolt will not be stressed further until sufficient weight has been added to W to cause the flanges to separate again. In this way, even with an intermittent load acting upon the parts joined by the bolt, the body of the bolt might be subjected to a steady load if the nut were set up tight enough, in the first place, to subject the bolt to a stress greater than the intermittent load. It would not be advisable to count on this, however, so that a factor of safety as low as 4 should never be used in any part of a marine engine. The lowest factor of safety that we shall use will be 8 for merchant engines and 6 for naval engines.

The parts subjected to intermittent loads are bolts, the threaded portion of piston rods and certain portions of valve stems. In the case of bolts and other threaded parts, a deviation from the chosen factor of safety 8 is made, because of the construction of the part. A piece of steel which has been nicked will fail at a lower stress, the net area at the nick being used, than if the same net area were in a piece without a nick. The sharp angle at the root of the threads has the same effect upon the bolt as the nick just referred to, so that the metal in the threaded portion cannot be stressed as greatly as it could be if the surface of the bolt were perfectly plain. The factor of safety to be used for bolts will be increased on this account to 10 for merchant engines and to 8 for naval engines.

Another condition which causes a further modification of the factor of safety for bolts is the initial torsional stress set up when the nut is put on, due to the friction between the threads of the nut and bolt. This initial stress is greater relatively in bolts of small diameter than in bolts of larger diameter, and can be considered as negligible in bolts of 3 inches diameter and above; so that, starting with a factor of safety of 10 for bolts of 3 inches diameter and above, it will be gradually increased until it is 16 for bolts of 1 inch diameter. In bolts for naval engines, the factor of safety will vary from 8 for bolts of 3 inches diameter and above to 14 for 1-inch bolts. Below is given a table of the factors of safety, areas and allowable loads upon bolts of various diameters, upon the assumption that steel of 60,000 pounds per square inch ultimate strength is used. For steel of higher strength, the allowable load is increased in proportion. It is customary to use not less than 4 threads per inch for the bolts of connecting rods, caps and main bearings and for the threaded portion of the piston rod.

When hexagonal nuts and heads are used, they are usually of standard dimensions, but a great many cylindrical nuts and heads and collar nuts are used. For cylindrical nuts, $d = 1.75\ D$ to $1.67\ D$, and $h = D$, where d = diameter of the nut, and h its height. D = diameter of the bolt.

For cylindrical bolt heads: $d = 1.5\ D$; $h = 0.67\ D$.

The ultimate strength of the materials used in marine engines will be assumed as follows:

Cast iron..................	20,000 pounds (tension).
Cast steel..................	55,000 to 70,000 pounds.
Wrought steel..............	60,000 to 100,000 pounds.
Phosphor bronze............	35,000 pounds.
Manganese bronze..........	50,000 pounds.

We give a table of collar nuts, where the flange of the part joined is counterbored to serve as a collar for the nut.

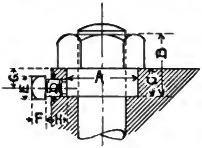


FIG. 5. DIMENSIONS IN INCHES.

TABLE IV.

Diameter of Bolt.	No. of Threads per Inch.	Area at Root of Thread.	Merchant. Factor of Safety.	Merchant. Allowable Load in Pounds.	Naval. Factor of Safety.	Naval. Allowable Load in Pounds.
3/4	10	.302	16.70	1,090	14.70	1,240
7/8	9	.420	16.40	1,540	14.40	1,755
1	8	.550	16.00	2,060	14.00	2,353
1 1/8	7	.694	15.60	2,670	13.60	3,065
1 1/4	7	.893	15.25	3,520	13.25	4,060
1 3/8	6	1.057	14.90	4,250	12.90	4,910
1 1/2	6	1.295	14.50	5,360	12.50	6,225
1 5/8	5 1/2	1.515	14.10	6,450	12.10	7,525
1 3/4	5	1.746	13.75	7,625	11.75	8,920
1 7/8	5	2.051	13.40	9,170	11.40	10,800
2	4 1/2	2.302	13.00	10,650	11.00	12,600
2 1/4	4	3.023	12.25	14,800	10.25	17,700
2 1/2	4	3.719	11.50	19,400	9.50	23,500
2 3/4	4	4.62	10.75	25,700	8.75	31,600
3	4	5.63	10.00	33,800	8.00	42,250
3 1/4	4	6.73	10.00	40,400	8.00	50,500
3 1/2	4	7.90	10.00	47,400	8.00	59,250
3 3/4	4	9.21	10.00	55,200	8.00	69,000
4	4	10.60	10.00	63,500	8.00	79,350
4 1/4	4	12.10	10.00	72,500	8.00	90,700
4 1/2	4	13.68	10.00	82,100	8.00	102,800
4 3/4	4	15.36	10.00	92,100	8.00	115,200
5	4	17.20	10.00	103,000	8.00	129,000
5 1/2	4	21.05	10.00	126,400	8.00	157,500
6	4	25.30	10.00	152,000	8.00	190,000
6 1/2	4	30.00	10.00	180,000	8.00	225,000
7	4	35.00	10.00	210,000	8.00	262,500

TABLE V.

Diameter.	A	B	C	D	E	F	G	H*	H†
1/2	13/16	7/8	3/16	1/4	3/8	1/4	5/16	5/16	3/8
9/16	7/8	7/8	3/16	1/4	3/8	1/4	5/16	5/16	3/8
5/8	1	1	3/16	1/4	3/8	1/4	5/16	5/16	3/8
3/4	1 3/16	1 1/8	5/16	5/16	7/16	5/16	3/8	3/8	7/16
7/8	1 3/8	1 1/4	5/16	5/16	7/16	5/16	3/8	3/8	7/16
1	1 9/16	1 3/8	3/8	3/8	1/2	5/16	7/16	7/16	1/2
1 1/8	1 3/4	1 1/2	3/8	3/8	1/2	5/16	7/16	7/16	1/2
1 1/4	1 15/16	1 5/8	3/8	7/16	5/8	3/8	1/2	1/2	5/8
1 3/8	2 1/8	1 3/4	3/8	7/16	5/8	3/8	1/2	1/2	5/8
1 1/2	2 5/16	2	3/8	7/16	5/8	3/8	1/2	1/2	5/8
1 5/8	2 1/2	2 1/8	7/16	1/2	11/16	7/16	9/16	1/2	3/4
1 3/4	2 11/16	2 1/4	7/16	1/2	11/16	7/16	9/16	1/2	3/4
1 7/8	2 7/8	2 3/8	7/16	1/2	11/16	7/16	9/16	1/2	3/4
2	3 1/16	2 1/2	7/16	1/2	11/16	7/16	9/16	1/2	3/4
2 1/2	3 3/4	2 7/8	1	5/8	13/16	1/2	11/16	5/8	7/8
3	4 1/2	3 3/8	1	5/8	13/16	1/2	11/16	5/8	7/8
4	6	4	1 1/4	3/4	1	5/8	3/4	3/4	1
5	7 1/2	5	1 1/2	7/8	1 1/8	3/4	1	7/8	1 1/8
6	9	6	1 3/4	1	1 1/4	13/16	1 1/8	1	1 1/4

* Wrought iron and composition. † Cast iron.

Sometimes the collar is a separate piece attached to the flange by pins or dowels.

CYLINDERS.

The cylinders may be divided into two classes; those with liners and those without liners. If the cylinders are to be jacketed, of course liners will be necessary, but very often liners are used when it is not intended that the space between the liner and the cylinder barrel shall be used for jacket steam. The presence of a liner makes it easier to warm up the engine before starting, by temporarily admitting steam to the jacket space. The liners are very simple in shape, and can be made of a tough grade of cast iron, which will give a good wearing surface for the piston rings, while the more complicated cylinder casting can be made of a softer grade, which will flow readily during casting. A further advantage in the use of a liner is that, if any accident happens to the piston, it may break the liner, which can be readily replaced, rather than the barrel of the cylinder, the replacing of which would necessitate the dismantling of a good part of the engine.

In deciding upon whether or not steam jackets are to be used, the following points should be considered: range of

temperature in one cylinder, temperature of steam to be used in jacket spaces and number of revolutions of cranks per minute. The layer of metal in the cylinder walls which is subjected to any great variation of temperature is usually comparatively thin, and the purpose of the steam jacket is to keep this layer as thin as possible. The layers of metal near the outside of the wall are almost constant in temperature, and the temperature of the jacket steam must be considerably higher than the natural temperature of the outside of the wall, in order that its effect may be felt upon the inner layers, and result in any reduction of the amount of metal subjected to variations of temperature. The use of boiler-pressure steam in the jackets of the high-pressure cylinder of triple and quadruple expansion engines has, therefore, very little beneficial effect upon the economy of the engine; and, if the space is not well drained of water, may have a harmful effect. It is quite common to use no steam in the high-pressure jackets, but to use jacket steam on the medium-pressure and low-pressure cylinders only. The element of time will also affect the thickness of the layer of metal subjected to variation of temperature, so that the higher the number of revolutions per minute the less need there is of jacket steam.

The load upon the cylinder walls of the high-pressure and medium-pressure cylinders is intermittent in character, varying from a minimum to a maximum. In the low-pressure cylinder, when a condenser is used, the pressure at times will be less than atmospheric, and consequently the load will be alternating in character. The load to be used in calculating the thickness of the walls will depend upon whether or not jacket steam is to be used. If the jackets are not to be used except for warming up, and reducing valves and relief valves are fitted, so that the pressure in the jackets cannot be greater than that for which they are designed, it may be assumed that the load upon the cylinder walls is as follows:

High-pressure — maximum	= boiler pressure, gage.
Triple; medium-pressure — maximum	= 0.5 boiler pressure.
Quadruple; first medium-pressure — maximum	= 0.6 boiler pressure.
Quadruple; second medium-pressure — maximum	= 0.4 boiler pressure.
Quadruple and triple; low-pressure — maximum	= 0.25 boiler pressure.

The maximum pressure in the low-pressure cylinder will seldom be more than 35 pounds absolute, or 20 pounds gage, and the back pressure seldom less than 4 pounds absolute, so the range of pressure would be 31 pounds, or about one-sixth of the absolute boiler pressure. When this is increased by 50 percent, to allow for the fact that it is an alternating load, we have one-quarter of the absolute boiler pressure as the equivalent load acting upon the low-pressure cylinder walls.

These assumptions are for the engine working under ordinary conditions. There are, however, other conditions which may exist at times, and for which allowance should be made. The high-pressure cylinder is liable to have water carried into it with the steam from the boiler; the medium-pressure and low-pressure cylinders may have their power increased by admitting live steam into the receivers, and so increase the pressure at which these cylinders take steam. Allowance for all these things is generally made by adding a fixed amount to the pressure assumed, so that the formula for barrels and liners is as follows:

$$t = \frac{(P + 25)D}{6{,}000} + \frac{40}{100 + D}, \qquad (15)$$

where t = thickness of walls in inches,

P = maximum pressure in cylinder, assumed as above,

and D = diameter of cylinder, as calculated.

Equation (15) may be used for cylinders without liners. When liners are used they may be calculated by (18), and the barrels made of the same thickness. When used for the liner the term

$$\frac{40}{100 + D}$$

adds something to the thickness, to allow for reboring later, and to insure that the walls shall be of a thickness practical for casting, if the diameter D is small. When (15) is used for the barrel of a cylinder with a liner, the

$$\frac{40}{100 + D}$$

is not needed for reboring, but is required because the barrel is larger in diameter than the liner, and may be thinner in places than designed, due to the displacement of the core during casting. Since the liner is finished inside, and at certain places outside, it will be of the designed thickness.

If jacket steam is to be used, and the pressure of the steam is to be greater than the $(P + 25)$ in the formula, the greater pressure should be used in obtaining the necessary thickness of barrel and liner.

All of the cylinder barrel thicknesses and liner thicknesses are usually made the same. The thickness for each cylinder can be found, and then an average taken, or only the thickness for the high-pressure cylinder need be figured, and all the others made the same. The thicknesses of the other parts of the cylinder and valve chest casting can be made some fraction of the liner or barrel thickness t, thus:

Thickness of cylinder bottom, single,	$= t$,
Depth of ribs of cylinder bottom, single,	$= 5t$,
Thickness of ribs of cylinder bottom, single,	$= t - 1/_{16}$ inch,
Thickness of cylinder bottom, double,	$= 0.9t$,
Distance between walls, double,	$= 5t$ (at least),
Thickness of cylinder flange,	$= 1.3t$ to $1.4t$,
Width of cylinder flange,	$= 2.75t$ to $3.25t$,
Thickness of metal in cylinder feet,	$= t$,
Thickness of flange on cylinder feet,	$= 1.5t$ to $1.75t$,
Diameter of bolts for cylinder feet,	$= 1.4t$ to $1.6t$,
Thickness of metal in cylinder cover, single,	$= t$,
Thickness of metal in cylinder cover, double,	$= 0.85t$,
Spacing of webs in cover and bottom	$= p = \frac{t \times 100}{\sqrt{P}}$,
Thickness of metal in valve liners,	$= t$,
Thickness of metal in ports and passages	$= 0.85t$ to $0.9t$.

The clearances are usually as follows:

TABLE VI.

Diameter of Cylinder.	Bottom Clearance.	Top Clearance.
16 to 24 inches	1/4 to 3/8 inch	3/16 to 1/4 inch
24 to 40 inches	5/16 to 1/2 inch	1/4 to 3/8 inch
40 to 60 inches	1/2 to 9/16 inch	3/8 to 1/2 inch
60 to 80 inches	9/16 to 11/16 inch	1/2 to 9/16 inch
80 to 100 inches	11/16 to 13/16 inch	9/16 to 5/8 inch
Above 100 inches	13/16 to 7/8 inch	5/8 to 11/16 inch

The general shape of the cylinder bottom and covers will be determined by the shape of the pistons used. The length of the cylinder must be such that a piston of the desired shape can travel the amount of the stroke, and have clearance at the top and bottom of the cylinder.

PISTONS.

The coned cast steel piston is the one most used, but sometimes the cast-iron box piston is used. The latter has the

shape shown in Fig. 6, and the usual proportions are as follows:

Depth of piston = $1.5d$ to $1.6d$, where d = diameter of piston rod.

Thickness of face of piston = $t = 0.0025 D \sqrt{P} + 0.33$ inch, where D = diameter of cylinder; $P = 0.5$ boiler pressure in high-pressure cylinder; $P = 0.25$ boiler pressure in medium-pressure cylinder; $P = 0.17$ boiler pressure in low-pressure cylinder.

Thickness near rim	$= a = 0.9t$,
Thickness of ribs	$= b = 0.9t$,
Thickness of boss around rod	$= c = 1.75t$,
Thickness of junk ring flange	$= e = 1.2t$,
Thickness of packing ring	$= f = 0.75t$,
Breadth of packing ring	$= g = 3t$,
Diameter of junk ring bolts	$= \frac{t}{2} + 0.25$ inch,
Pitch of junk ring bolts	= 10 diameters.

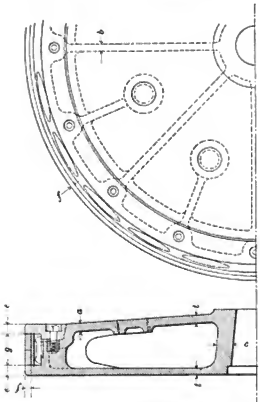


FIG. 6.

When cast steel pistons are used they are all made, when possible, of the same over-all depth, as shown in Fig. 7, the details of the rim being the same for all. The slope on the under side of the low-pressure piston varies from 1 in 3 to 1 in 6; the steeper this slope is made the longer the piston rod must be, and the greater the total height of the engine. The flange on the foot of the cylinder attaching it to the housings, or frame, must be sufficiently far below the under surface of the cylinder bottom to allow the nuts on the bolts in the flanges to be set up.

Figs. 8, 9 and 10 show some of the ways in which the cylinder bottom may be constructed to fit the pistons. The construction shown in Fig. 9 can be used when the low-pressure piston has a steep slope on the underside, but the construction shown in Fig. 8 is much stronger.

When cast steel pistons are used, the thickness at the rim

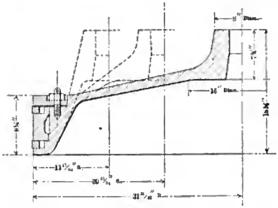


FIG. 7.

and at the center line of the boss can be obtained from the following formulæ:

$$\text{At the center,} \quad t = \frac{D}{200}\sqrt{P} + 0.25 \text{ inch.} \tag{16}$$

$$\text{At the rim,} \quad t' = 0.5t, \tag{17}$$

where D = the diameter of the cylinder, and P may be taken as follows:

Ratio of Boiler Pressure for	Triple.	Quadruple.
For the high-pressure cylinder,	$P = 0.5$	$P = 0.45$
For the first medium-pressure cyl.,	$P = 0.25$	$P = 0.20$
For the second medium-pressure cyl.,		$P = 0.175$
For the low-pressure cylinder,	$P = 0.20$	$P = 0.10$

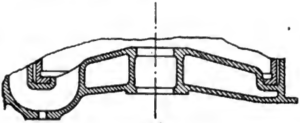


FIG. 8.

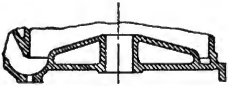


FIG. 9.

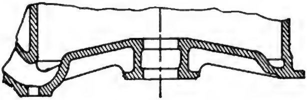


FIG. 10.

The construction of the pistons at the rim and at the boss is usually the same for all cylinders of the engine, except that, when the high-pressure cylinder is of small diameter, it is sometimes necessary to make a modification. Some of the constructions used for rims are shown in Figs. 11, 12, 13 and 14. The dimensions to be used in any case should be determined by the diameter of the low-pressure cylinder. The

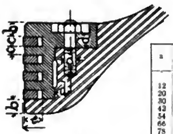


FIG. 11.

a	b	c	d	e	No. of Rings.
12	1 1/4	3/4	1	11/16	2 or 3
20	1 1/2	3/4	1	13/16	2 or 3
30	1 3/4	7/8	1 1/8	1 1/8	3
42	1 3/4	7/8	1 1/8	1 3/8	3 or 4
54	1 7/8	1	1 1/8	1 5/16	3 or 4
66	2	1	1 1/4	1 11/16	3 or 4
78	2	1 1/16	1 1/4	1 3/4	3 or 4

Dimensions in inches.

depth of the pistons at the boss should be from 1½ *D* to 1¼ *D*; 1½ *D* for piston rods up to 6 inches in diameter, and ranging from 1½ *D* to 1¼ *D* for rods from 6 inches to 11 inches in diameter. *D* is the diameter of the piston rod. The

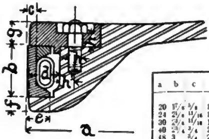


FIG. 12.

a	b	c	d	e	f	g	h
20	1 7/8	5/8	1 1/2	15/16	1 1/4	2 1/4	1
24	2 1/8	11/16	1 11/16	1 1/16	1 1/4	2 1/4	1
30	2 3/8	11/16	1 7/8	1 3/16	1 1/8	2 1/2	1 1/8
40	2 3/4	3/4	2 1/8	1 1/8	1 5/8	2 1/2	1 1/8
48	3	3/4	2 3/8	1 1/2	1 3/4	2 1/2	1 1/8
60	3 3/8	3/4	2 5/8	1 11/16	1 7/8	2 3/4	1 1/4
75	3 1/2	7/8	2 7/8	1 13/16	2	2 3/4	1 1/4
100	4	7/8	3 1/4	2	2 1/4	2 3/4	1 1/4

Dimensions in inches.

diameter of the boss should be sufficient to afford bearing for the nut on the end of the piston rod, the design of which will be taken up later. The underside of the piston at the center

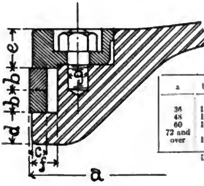


FIG. 13.

a	b	c	d	e	f	g
36	1	3/4	2	2 1/8	1 1/2	1 3/8
48	1 1/8	7/8	2 1/8	2 1/2	1 5/8	1 1/8
60	1 1/8	7/8	2 1/8	3	1 5/8	1 1/4
72 and over	1 1/4	1	2 1/4	3	1 3/4	1 3/4

Dimensions in inches.

is usually made horizontal for a distance from the center equal to

$$\frac{D}{10} + 1.5 \text{ inches},$$

where D = the diameter of the low-pressure cylinder.

CYLINDER COVERS.

The shape of the underside of the cylinder cover is determined by the shape of the top of the piston. The distance *a*, Figs. 15 and 16, from the underside of the cover to the bottom of the flange, is determined by the height of the steam port entering the cylinder, and the thickness of metal above the port needed for the studs of the cylinder cover. The height of the port is generally from 4½ to 7 inches, depending upon the area necessary in order that the steam may enter with the desired speed.

The breadth of the joint between the cover and the barrel should be from 2.75 *d* to 3.25 *d*, being usually 3 *d*, where *d* is the diameter of the stud connecting the flanges. The studs

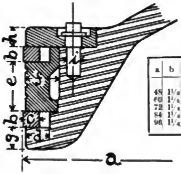


FIG. 14.

a	b	c	d	e	f	g	h	i
48	1 1/8	1	1 3/4	3	2 1/2	1 1/2	1 1/2	1 1/8
60	1 1/8	1	4 3/4	3	2 1/2	1 1/2	1 1/2	1 1/8
72	1 1/8	1 1/8	1 7/8	3 1/4	2 3/4	1 5/8	1 5/8	1 1/4
84	1 1/8	1 1/8	1 7/8	3 1/4	2 3/4	1 5/8	1 5/8	1 1/4
96	1 1/4	1 1/8	2	3 1/2	3	1 3/4	1 3/4	1 1/4

Dimensions in inches.

should be spaced far enough apart to allow a wrench to be used freely, and near enough together to make the joints steam tight. For the sake of convenience and simplicity, it is usual to calculate the studs which should be used for the high-pressure cover, and then to use the same size of stud upon the other cylinder covers, increasing the spacing as the steam pressure decreases.

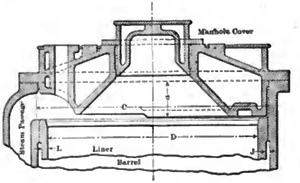


FIG. 15.

When a liner is used the inner surface of the barrel will have a diameter equal approximately to

$$C = D + 2L + 2J, \tag{18}$$

where D = the diameter of the cylinder,
L = the thickness of the liner,
J = the width of the jacket space, usually ¾ inch or 1 inch.

The load upon the cover will be the area of a circle of diameter C multiplied by the gage boiler pressure:

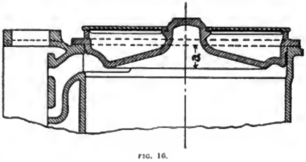


FIG. 16.

$$\text{Load on cover,} = \frac{\pi C^2}{4} \times (B.P.) \qquad (19)$$

The cover studs should be spaced from 2.75 d to 3.25 d on the high-pressure cylinder, and the diameter of the pitch circle for these studs, upon the assumption that the width of joint is to be 3 d, will be $C + 3d$. The total load to be carried by the studs being known, a diameter of stud d, equal approximately to the thickness of the barrel, should be selected. Table IV. gives the load that the stud can carry, so that the total number necessary can be found.

$$\frac{(C + 3d)\pi}{\text{number of studs}} = \text{spacing of studs,}$$

which should be from 2.75 d to 3.25 d. If the studs cannot be brought near enough together except by taking d less than ¾ inch, the diameter is taken as ¾ inch, and enough studs used to bring the spacing right. The spacing upon the medium-pressure cylinder cover should be from 4 d to 5 d, and upon the low-pressure cover from 5 d to 6 d. It is well to tabulate the results, as shown later in the calculations.

The nuts used on the cover studs are often thicker than the standard nut, in order that they may stand frequent handling. Covers for cylinders over 35 inches in diameter should have manholes in them, usually in the center of the cover. These manholes should be not less than 16 inches in diameter, and constructed as shown in Fig. 15. Manholes are frequently placed in the bottom of the cylinders, to give access to the underside of the piston without taking off the cover and removing the piston. These have to be placed where they will clear the upper end of the connecting rod.

CALCULATIONS FOR CYLINDERS AND PISTONS.

The use of the formulæ given will be illustrated by continuing the calculations for the engine whose cylinder diameters and cut-offs have been previously determined.

The assumptions and calculations made so far give us

I. H. P. = 3,000, P. S. = 850 feet per minute, B. P. = 185 pounds gage
Cylinder diameters and stroke, 23½", 41", 64" × 42".
Cut-offs: H. P. = 0.675, M. P. = 0.60, L. P. = 0.65.

Cylinders.—Formula (15):

$$\text{H. P. cylinder liner and barrel, } t = \frac{(185 + 25)23.5''}{6{,}000} + \frac{40''}{123.5}$$
$$= 1.147''(\text{Use } 1\tfrac{1}{8}'')$$

$$\text{M. P. cylinder liner and barrel, } t = \frac{(100 + 25)41''}{6{,}000} + \frac{40''}{141}$$
$$= 1.136''(\text{Use } 1\tfrac{1}{8}'')$$

$$\text{L. P. cylinder liner and barrel, } t = \frac{(50 + 25)64''}{6{,}000} + \frac{40''}{164}$$
$$= 1.044''(\text{Use } 1\tfrac{1}{16}'')$$

Make the thickness of all cylinder barrels and liners 1⅛".
Use double walls in covers and bottoms.

Thickness of cylinder bottom
$$= 0.9 \times 1.125'' = 1.01'' \ (\text{Use } 1'').$$

Distance between walls of cylinder bottom
$$= 5 \times 1.125'' = 5.625'', \text{ at least.}$$

Thickness of cylinder flanges
$$= 1.3 \times 1.125'' = 1.46'' \ (\text{Use } 1\tfrac{1}{2}'').$$

Width of cylinder flanges = 3 d.

Thickness of metal in cylinder feet
$$= 1.125''.$$

Thickness of flanges on cylinder feet
$$= 1.5 \times 1.125'' = 1.69'' \ (\text{Use } 1\tfrac{3}{4}'').$$

Diameter of bolts for cylinder feet
$$= 1.4 \times 1.125'' = 1.58'' \ (\text{Use } 1\tfrac{5}{8}'').$$

Thickness of metal in cylinder cover
$$= 0.85 \times 1.125'' = 0.955''(\text{Use } {}^{15}/_{16}'').$$

Maximum spacing of webs in bottom and cover:

$$\text{H. P.,} \ \frac{1.125'' \times 100}{\sqrt{185}} = 8.3''. \quad (\text{Use } 8\tfrac{1}{4}''.)$$

$$\text{M. P.,} \ \frac{1.125'' \times 100}{\sqrt{100}} = 11.25''.$$

$$\text{L. P.,} \ \frac{1.125'' \times 100}{\sqrt{50}} = 15.9''. \quad (\text{Use } 16''.)$$

Thickness of metal in valve liners
$$= 1.125''.$$

Thickness of metal in ports and passages
$$= 0.9 \times 1.125'' = 1.01''. \quad (\text{Use } 1''.)$$

Piston clearances:	H. P.	M. P.	L. P.
Top..................	⅜"	⅜"	7/16"
Bottom..............	½"	½"	11/16"

Pistons.—Formula (16):

$$\frac{23.5''}{200} \times \sqrt{100} + 0.25'' = 1.43'', \text{ high-pressure.}$$

$$\frac{41''}{200} \times \sqrt{50} + 0.25'' = 1.70'', \text{ medium-pressure.}$$

$$\frac{64''}{200} \times \sqrt{40} + 0.25'' = 2.03'', \text{ low-pressure.}$$

Formula (17): $0.5 \times 1.43'' = 0.715''$, high-pressure.
$0.5 \times 1.70'' = 0.85''$, medium-pressure.
$0.5 \times 2.03'' = 1.015''$, low-pressure.

Depth of piston at boss $= 1.5 \times 5.25'' = 7.87''$. (Use 7⅞".)

Diameter of cylindrical nut on top of piston rod $= 4'' \times 1.75 = 7''$ (See below.) Top of boss to be 8 inches diameter

Radius of horizontal portion of the underside of piston

$$= \frac{64}{10} + 1.5'' = 7.9''. \quad (\text{Use } 8''.)$$

The diameter of the body of the pistons will be:

High-pressure,	$23\tfrac{1}{2}'' - {}^{1}/_{32}'' = 23^{15}/_{32}''$.
Medium-pressure,	$41'' - {}^{1}/_{32}'' = 40^{31}/_{32}''$.
Low-pressure,	$64'' - {}^{1}/_{16}'' = 63^{15}/_{16}''$.

The details of the piston are shown in Figure 7.

Bolting for Cylinder Covers.—Formula (18):

$$C = 23.5'' + 2 \times 1.125'' + 2 \times 0.75'' = 27.25''.$$

$$\text{Load on cover} = \frac{\pi(27.25)^2}{4} \times 185 = 108{,}000 \text{ pounds.}$$

Try 1⅛-inch studs of 70,000 pounds ultimate strength, which (see Table IV.) can carry 3,115 pounds each.

$$\frac{108{,}000}{3{,}115} = 35. \quad (\text{Approximately.})$$

$$27.25'' + 3 \times 1.125'' = 30.625'';$$

$$\text{Circumference of pitch circle} = 30.625 \times \pi = 96''; \quad \frac{96''}{35} = 2.75'';$$

$$\frac{2.75''}{1.125''} = 2.44 \text{ diameters; (Too close).}$$

Try 1¼-inch studs. Working load = 4,110 pounds.

$$\frac{108{,}000}{4{,}110} = 26. \quad (\text{Approximately.})$$

$$27.25'' + 3 \times 1.25'' = 31''; \quad 31'' \times \pi = 97.3'';$$

$$\frac{97.3''}{26} = 3.75''; \quad \frac{3.75''}{1.25''} = 3 \text{ diameters; (Use } 1\tfrac{1}{4}\text{-inch studs).}$$

Cylinder Cover Studs. Cylinder.	Diameter.	Diameter of Stud.	Pitch Circle of Studs.	Number of Studs.	Spacing of Studs, Diameters.
High......	23.5"	1.25"	31"	26	3.
Medium...	41"	1.25"	48¾"	29	4.2
Low.......	64"	1.25"	71¾"	33	5.44

(*To be Continued.*)

RESULTS OF FURTHER MODEL SCREW PROPELLER EXPERIMENTS.*

BY R. E. FROUDE, F. R. S.

Efficiency.—We have next to consider the efficiency reduction. The variation of efficiency with pitch ratio makes it impossible to bring all the results under one single efficiency curve, as was done for the 1884 experiments. It was therefore necessary to obtain a series of efficiency curves for a convenient series of round-number pitch ratios, such as appear in Fig. 6, plotted to the base "x" of the "x y" curve. This diagram, as well as that in Fig. 7, to avoid confusion, shows curves for an abridged series of pitch ratios. These are correct for the three-blade elliptical type of screws, and for a standard disk-area ratio of 0.45. To correct them for another type or disk-area ratio, or both, a uniform efficiency reduction must be made, of .020 for three-blade wide tip, or .0125 for four-blade elliptical, also one appropriate to the disk-area ratio and pitch ratio in question, as indicated by the ordinates of the efficiency correction curves, to base disk-area ratio, in Fig. 5.

Efficiency for a pitch ratio intermediate between those for which the series of efficiency curves are shown has to be obtained by interpolation, but in nearly all cases of practical occurrence the successive curves are so near together that this can readily be done by eye.

The series of efficiency curves for the series of round-number pitch ratios, already referred to, were obtained from those for the four pitch ratios of actual experiment, which appear in Fig. 8, by means of cross curves, such as are shown in Fig. 9. In the former diagram, the curves are carried to unity slip ratio, and in the latter to zero of pitch ratio; in both cases, of course, far beyond the experimental data; this being done to help guide the directions of the curves at the confines of the data. In thus extending the compass of the curves, as well as in fairing them throughout, regard was had, so far as the experiment data left room for any question, to the theoretically calculated curves in Figs. 10 and 11, on which I comment later.

Design.—The "x y" curve, with its companion efficiency curves, serves perfectly for analysis of steam trials, where it is needed only to calculate thrust horsepower and efficiency, for known revolutions per minute and speed, with known propeller dimensions. But, for design, where it is generally

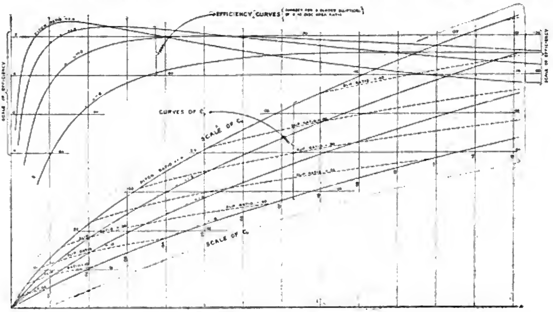


FIG. 7.—EFFICIENCY CURVES OF C_0, BASED ON SCALE OF C_A.

desired to calculate propeller dimensions suitable to given horsepower, revolutions and speed, a difficulty arises from the fact that diameter, an unknown quantity, enters into both x and y. So, for purposes of design, there were devised the curves in Fig. 7, for which the abscissa "C_A" is determined solely by the known horsepower, revolutions and speed; while the corresponding ordinate "C_0" determines the unknown diameter in terms of the same known quantities. The expressions for these two values are

$$C_A = \frac{R^3\ H}{B\ V^5}\left[= \frac{p + 21}{p^3} \cdot x^2 y \right] \qquad (7)$$

$$C_0 = \frac{H}{B\ D^2\ V^3}\left[= \frac{p + 21}{p} \cdot y \right] \qquad (8)$$

Unlike the "x y" curve, this curve differs with pitch ratio; a series of curves is therefore shown, for the same series of pitch ratios as the series of efficiency curves accompanying the "x y" curve, which series of efficiency curves is also reproduced on the C_A base to accompany the curves of C_0.

The x y curves *can* be used for design, though with indifferent convenience, as follows: If we choose a value for p, a series of chosen values of x, with the corresponding ones of y, determine corresponding ones of D from V and R by equation (5), and thence ones of B from V and H by equation (6). Thus we can get curves of D to base B (or propeller area if preferred) for a series of values of p. The main objection is that for chosen p there is a very small range of choice of x without exceeding the practical range of B.

Unfortunately, it is never practicable to treat pitch ratio as

* Read before the Institution of Naval Architects, April 10, 1908.

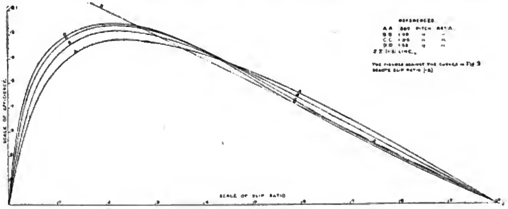


FIG. 8.—EXPERIMENTAL EFFICIENCY CURVES, BASED ON SLIP RATIO.

an unknown quantity. Our usual practice in using these data is to obtain diameter and efficiency for two or more of the pitch ratio values for which curves are given, each for two or more values of disk-area ratio, and plot the results on a base of total blade area. In this way the diameter and efficiency for any intermediate pitch ratio is indicated. The disk-area ratio being reckoned for total area of outline without boss allowance, in computing the total blade area for ship propeller from the diameter and disk-area ratio, a discount must be made, to allow for portion of area covered by boss. In our general practice at Haslar this discount is 20 percent.

Nominal Pitch.—It may be recollected that in the system of analysis and reduction just described, the pitch P, corresponding both to the pitch ratio p and the slip ratio S, is throughout taken as equal to the travel per revolution for zero thrust; in other words, the revolutions of zero-thrust are taken as the zero of the slip-ratio scale. Comparison of the figures which we have calculated from these data with the realization in actual ships have led to the conclusion that the pitch of pitch ratio figures used or obtained in these calculations, which we may term "analysis pitch," should be taken as 1.02 times the nominal (or driving-face) pitch for ship.

For present purposes, I prefer this result of net experience to any estimate based on the relations between "analysis" pitch and constructional pitch in the model screws, partly because I question the adequate nicety of the pitch molding of the model propellers for such a purpose, partly because of the differences of condition between ship propellers in use, and model propellers under experiment, some of which are referred to above.

THEORETICAL EFFICIENCY CURVES.

The curves shown in Figs. 10 and 11 have been computed on three different bases. No. 1 of these is the solution of Mr. William Froude's paper of 1878,‡ obtained from the rotary and thrust components of the estimated edgewise and normal resistance of an elementary plane, mounted on a revolving radius, obliquely to the plane of rotation. The other two are the same in principle (slightly different mathematics), but the resistance forces of the supposed plane or blade are obtained from the experiments made at Haslar some years ago on planes and blades moving obliquely at various angles. In No. 2 the plane was oval and thin, with edges symmetrically sharpened; in No. 3 the *blade* (as it must more properly be termed) was rectangular, and flat all over the front face, but rounded on the back like a screw blade, the mid-thickness being about one-seventeenth of the width. In both the length was twice the width, and the length was transverse to the line of motion.

The planes or blades were tried at various angles of obliquity from the path, and the components of force, R in line of path and L transverse to it, measured. I am indebted to Mr. Arnulph Mallock for the following charmingly simple solution of the efficiency of such plane or blade mounted on a revolving radius and treated as an elementary screw propeller, as in Mr. William Froude's solution. In figure C let A B be the path of plane (A towards B), A C the plane of rotation, C B the line of axis, and V the speed of advance (C towards B), then we shall have

(1) In respect to force L,

‡ *Transactions Institution of Naval Architects*, Vol. XIX., page 47.

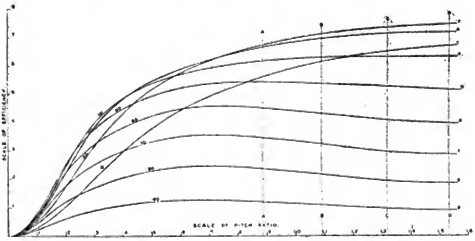


FIG. 9.—EXPERIMENTAL EFFICIENCY CURVES, BASED ON PITCH RATIO.

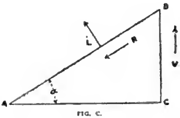


FIG. C.

U_L, *i.e.*, Useful power $= V L \cos \alpha$,

E_L, *i.e.*, Expended power $= V L \cos \alpha$.

(2) In respect to force R,

U_R, *i.e.*, Useful power $= - V R \sin \alpha$,

$$E_R, \text{ i.e., Expended power } = V \frac{\cos \alpha}{\sin \alpha} R \cos \alpha = V R \frac{\cos^2 \alpha}{\sin \alpha}$$

whence

$$\text{Efficiency} = \frac{U_L + U_R}{E_L + E_R} = \frac{1 - \frac{R}{L} \tan \alpha}{1 - \frac{R}{L} \cot \alpha},$$

or, writing

$$\frac{R}{L} = \tan y$$

$$\text{Efficiency} = \frac{\tan \alpha}{\tan (\alpha + y)}.$$

This was the solution used in computing the curves for bases Nos. 2 and 3.

It will be seen that in Fig. 10, Nos. 1 and 2 follow each other pretty closely, as might be expected, but that No. 3 differs from the two others in a striking way in the regions of higher slip, in this respect according with the results of the screw experiments, as shown in Fig. 8. The curves in Fig. 8 terminate at zero of slip ratio, while those of Fig. 10 do not, because the latter are calculated for pitch of surface, but the former for pitch equal to travel per revolution at zero thrust, therefore necessitating zero efficiency at zero of slip ratio. This circumstance turns on a rather important theoretical point, as follows:

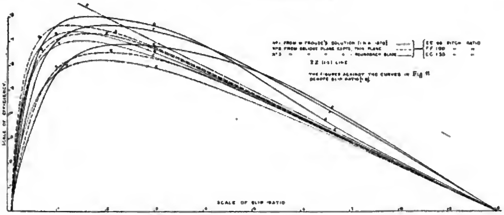


FIG. 10.—THEORETICAL EFFICIENCY CURVES, BASED ON SLIP RATIO.

In the ideal case of a screw with no edgewise resistance, where, in other words, the turning moment must be simply the virtual-velocity component of the thrust, the sole waste would be slip, and the efficiency would be always $= (1 - S)$. This expression, indicated by the ordinates of the straight line $Z Z$ in Figs. 8 and 10, may therefore be regarded as the theoretical limit of efficiency, from which an actual screw must fall short in virtue of the edgewise resistance element. But it will be seen that the actual screw curves in Fig. 8 begin to trespass *outside* this line before even 30 percent slip is reached. The comparison between the theoretical curves for bases Nos. 2 and 3 proves clearly that this feature is incidental to the roundness of back of the blades, which must obviously operate to increase the effective pitch [and so falsify the $(1 - S)$ line]; and this not by a constant amount, since the increase at no slip has already been taken account of in the mode of assessing the analysis pitch, but by an amount which increases markedly as slip ratio increases.

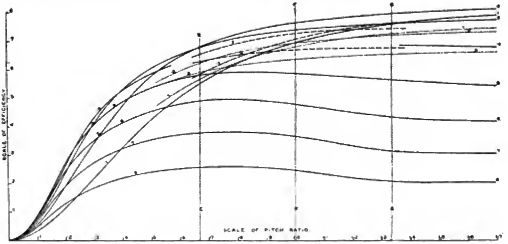


FIG. 11.—THEORETICAL EFFICIENCY CURVES, BASED ON PITCH RATIO.

In reference to Fig. 11, it should be noted that the ordinates of the curves for basis No. 3 have been calculated for the following pitch ratio values: .05, .10, .20, .33, .50, .66, 1.0, 1.33,

1.06, 2.0, 2.4. The finish tangential to the base line at the zero pitch ratio end is consonant with theory, because, in the limiting case, for given revolutions per minute, turning moment and work expended are constant, whereas for given slip ratio, both thrust and speed vary as pitch, and useful work consequently as pitch squared. The pitch ratio figures assigned to the theoretical curves in Fig. 10, and to which they are plotted in Fig. 11, are taken as two-thirds of the values proper to the actual supposed path of the plane or blade; on the supposition that the mean diameter of an ordinary screw may be taken as about two-thirds of the reputed diameter.

THE HEATING AND VENTILATING OF SHIPS.

BY SYDNEY F. WALKER, M. I. E. E.

NON-LUMINOUS HEATING APPARATUS WITH LOOSE POWDER.

There is another form of electric heating apparatus, which has been developed in Germany, principally, in which a loose powder is employed, the necessary resistance being obtained partly by means of the substance of which the powder is composed and partly by the fact that the substance is in a powder, or in loose grains. A loose powder, or loose contact between any two conductors, across which an electric current has to pass, always offers a considerable resistance over and above that due to its own sectional area, length, etc. This is the cause of the heating of badly designed switches. If the contact portions of a switch do not make good contact with each other, heat is always liberated at the surfaces, and sometimes arcs are formed with the attendant enormous heat.

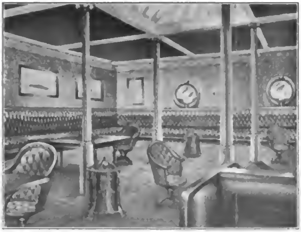


FIG. 35.—SALOON ELECTRICALLY HEATED BY HAWKES' STOVES.

One form of this heating appliance is known as "Kryptol." It is a granular mass of very inoxidizable substances, carbon, graphite, carborundum and silicious matters. These substances are ground together and then pressed into blocks, and afterwards made into grains of a uniform size. The grains for different types of apparatus vary in size from a sand to the size of grains of wheat, with varying amounts of graphite and carborundum, according to the particular applications for which they are required. The substance is claimed to stand temperatures up to 3,000° F.; and, on the other hand, it is claimed that temperatures as low as 50° F. can be obtained.

The powder or grain is filled into cartridges, as shown in Fig. 36. These cartridges consist of tubes of special glass, in which the resistance material is held, the ends of the tubes being hermetically sealed with metallic capsules, which form the connections to the powder. The cartridges are heated with an electric current before they are finally closed by the cap-

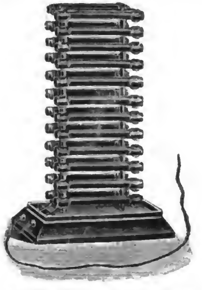


FIG. 36.—KRYPTOL CARTRIDGES BUILT INTO FRAME.

sules, in order to eliminate grains of un-uniform size, and also to get rid of the moisture. One of the troubles met with in working out this form of apparatus, after the capsules had been fixed, was the generation of steam within the cartridge when the current was allowed to pass through, the steam bursting the glass-containing tubes. To meet this difficulty, any moisture that may be present is driven off by the heat of an electric current, the moisture forming steam, and the heating being kept up until this has all disappeared, and the whole mass is thoroughly dry, and until dry air is present between the grains of the substance. The cartridges are built into various forms, and are arranged as radiators, or convectors, whichever term may be preferred, some of which are shown in Figs. 37 and 38.

Kryptol is also used, in certain cases, in what are practically open fireplaces. The grains are loosely heaped in a vessel of fireproof clay, the current being led to the mass by conductors projecting into them. For other purposes also the Kryptol grains are spread loosely on a plate that it is desired to heat, or in an annular space surrounding an object to be heated, etc.

The action of the substance is as follows: When the current is first switched on, small arcs are sometimes formed between the individual grains, this leading to the very rapid development of heat. But in the cartridge tubes, providing that they are properly prepared, it is claimed that the formation of arcs has been practically suppressed. In either case, whether arcs are formed or not, the substance settles down usually to a dull red heat, which may be increased up to the high temperature named, if sufficient current is passed through

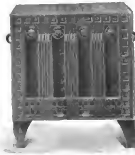


FIG. 37. KRYPTOL CABIN HEATERS. FIG. 38.

it for a sufficient time. Where the substance is used loose, practically in air, the formation of the arcs mentioned leads to the burning away of the substance itself by the formation of carbonic oxide and carbonic acid, just as in an ordinary furnace or in an arc lamp. It is stated, however, that the powder can remain, with the current passing through it, for several hours before it need be renewed.

Some tests that have been made upon a stove intended for heating rooms and containing twenty cartridges inside a cover of expanded metal are interesting. They are shown by the curve in Fig. 39. In the figure the ordinates are temperatures in degrees Centigrade, and the abscissæ represent time in minutes. The stove was used to heat up a room, whose initial temperature was 10° C. (50° F.), the outside temperature being 2° C. (35.6° F.). The current employed was 9 amperes, with a pressure of 120 volts—a little over one kilowatt, or Board of Trade unit.

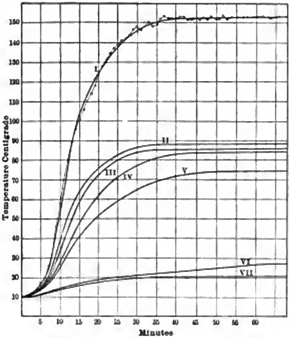


FIG. 39.—TEMPERATURE CURVES OF CARTRIDGE STOVE.

In the figure, line I. shows the variation of the temperature of the air between the two upper cartridges, with the cover of the stove removed. The cartridges were in two vertical rows of ten each, and the temperatures given would be between the two upper ones, just inside the top of the stove. It will be seen that the temperature rises in 10 minutes from 10° C. (50° F.) to 60° C. (140° F.). In 15 minutes it has risen to 100° C. (212° F.); in 20 minutes to 124° C. (255° F.). After this the rise is more gradual, reaching 150° C. (302° F.) in 35 minutes, and 152° C. (305.6° F.), at which it remains constant to the end of the test, which occupied an hour. Curve II. shows the temperature on the center of the cover, which was presumably replaced. It will be noticed what a great difference there is between the temperature of the cover and that of the air inside of the apparatus between the cartridges. The rise of temperature is still very equal, and it reaches 65° C. (149° F.) in 15 minutes, but it reaches 88° C. (190° F.) only in 35 minutes, and does not rise any higher to the end of the test. Curve III. is the temperature of the air of the room 20 millimeters (¾ inch) above the top of the cover. It will be noticed that the temperature follows the same course as that of the cover itself, but is about 4° C., say 7° F., less. Curve IV. is the temperature of the top of the frame carrying the cartridges, which, it will be seen, follows the course of curves II. and III. fairly closely, with a certain difference between them. Curve V. is the temperature of another portion of the cover, not subject to side currents of air. It does not present much interest. Curve VI., which is the most interesting one of the whole, is the temperature of the room one meter (39⅜ inches) above the cover; and curve VII. is the average temperature of the air in the room. It will be seen that the temperature of the air, one meter above the cover, and the average temperature of the room, are very nearly alike, that a short distance above the cover being slightly higher than the average temperature, and being about 7° C. (12.6° F.) above it at the end of the test. Both curves, however, rise very gradually. It takes 25 minutes to increase the temperature 10° C. (18° F.) one meter above the stove, and 30 minutes for

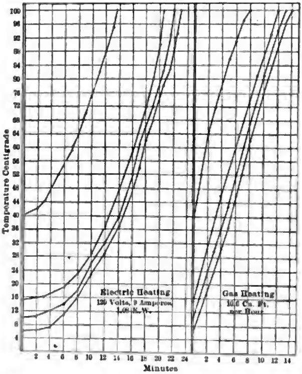


FIG. 40.—HEATING TO BOILING POINT OF ONE LITER OF WATER.

the average temperature of the room to reach the same figure. The temperature of the air, one meter above the stove, rises very gradually, it will be seen, to about 27° C., while the average temperature of the room rises to only about 21° C. (70° F.).

There is another instructive series of curves given of tests with a Kryptol stove, shown in Fig. 40. There are several curves, those on the left of the figure giving the rise of temperature in the time shown, with the Kryptol apparatus, and those on the right the rise of temperature in the time shown, with gas. The gas employed appears not to have been by any means the most efficient for heating. It was an open gas flame, which is certainly not designed for heating. As will be seen, the electrical apparatus takes 10 minutes to reach a temperature of 28° C. in the best of the three curves shown, and over 20 minutes to reach 100° C., while gas reaches 30° C. in the worst of the curves shown in 4 minutes, and 100° C. in 14 minutes.

The above curves are taken from an article in the *German Export Zeitschrift*, dealing with the subject. The article also gives some other interesting information, which there is hardly

space to reproduce here. Some other curves are given, which show that the current required rises to a maximum, and then falls to a "working" current. This is the common experience with a great many forms of heating apparatus. If the air of a room is required to be heated up quickly, a considerable amount of heat has to be supplied to the apparatus for a short time, and then it may be reduced, the air then keeping its temperature with a smaller expenditure.

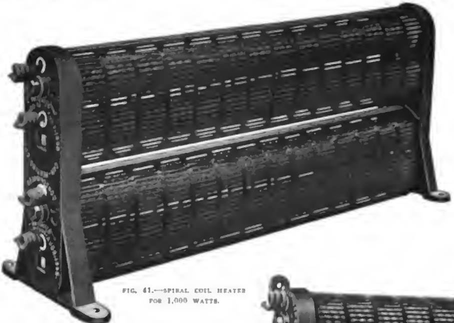


FIG. 41.—SPIRAL COIL HEATER FOR 1,000 WATTS.

The Kryptol cartridges described are made in the following sizes: 5½, 7¾, 10, 12¾ and 20 inches long, by 0.6 and 0.8 inch diameter respectively. The 12¾-inch cartridge takes 0.3 ampere with a pressure of 100 volts, and the cartridge is stated to receive with that current and pressure an increased temperature of 100 degrees. These figures are for the cartridge when exposed. When inclosed, the conductivity of the mixture rises with the temperature, and the cartridge will take 0.4 ampere with 110 volts.

It will be understood, as explained in connection with hot water and steam heating, that the above remarks apply to heating, without having any regard to the question of ventilation. As will be explained, heating and ventilation are now usually considered together, the ventilating air current being employed for heating and cooling purposes. In many cases, however, no attention whatever is paid to ventilation, and this is particularly the case with electrical heating appliances.

It will be understood that any heating appliance may be fixed in any room, passage, alleyway, etc., and will give off heat, exactly in the proportion described, but the heat given off may or may not be useful heat. In the case of corridors, one very frequently sees here a heating appliance, which is practically useless, because there is an air current constantly passing over it, and constantly carrying off the heat that is liberated, without doing any useful work. The same remark would apply to a room that is very subject to drafts. The heating appliance would do very little good. On the other hand, if a heating appliance is placed in a room, say in the middle of a saloon, and is not exposed to drafts, it will heat up the air of the saloon, by radiation and convection, in a certain time, varying with the conditions, but the heating will be hardly under the control of the engineer in the same manner as it is when the appliances are so arranged, as will be described later, as to utilize the warmed air currents.

SPIRAL COIL HEATERS.

A type of electric heater made by the Consolidated Car Heating Company, New York, and fitted for marine use, is on the McElroy spiral coil construction, in which the resistance coils are perfectly supported at every point, rendering vibration impossible. The spindle supporting the coil consists of a ⅜-inch square wrought iron rod, on which are strung porcelain tubes, so designed and fitted that a helical groove

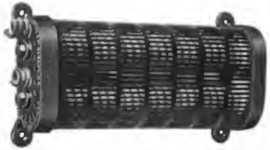


FIG. 41A.—SMALL SPIRAL COIL HEATER FOR STATEROOM.

extends from end to end. The iron wire for the resistance coil is wound in a close spiral spring, and insulated copper leading wires are attached to both ends by twisted and soldered joints. This coil is wound between the ridges on the porcelain spindle, under suitable tension, and the leading wires are passed through eccentric bushings at the ends and firmly fastened to the exterior part of the circuit. This construction gives the greatest possible length of wire in the given space, and so disposes every portion of the large surface presented that a large quantity of air comes freely into contact with it, and passes out in a steady stream at such temperature as may be designed.

Two views of this type of heater are given in Figs. 41 and 41A. The former is designed for the use of 1,000 watts (1 kilowatt) of current, measures 27 inches in length, 15⅜ in height and 3 9/16 in thickness. The "spread" for bolt holes is 7 inches, and the heater, which contains four coils, is finished in black japan. The smaller heater shown has only two coils, and measures 4⅛ inches in thickness, with a spread of 6½ inches. The length is 15⅜ inches, while the oval of the case measures 5¾ by 3⅝ inches. The case is of heavy, perforated sheet steel.

LOW TEMPERATURE AIR HEATER, TUBULAR TYPE.

The latest in air heater design is the so-called "low temperature air heater." The specifications of the United States

battleship *Louisiana* called for electric heaters which should have an operating temperature equivalent to that of steam piping. As a result, the General Electric Company's engineers designed the tubular type of air heater shown in the accompanying illustration, and furnished it to the *Louisiana*. This particular type of heater consists of three or more tubular heating elements inclosed by the metal "chimney" tubes which are shown. Each tube dissipates 250 watts. The principle of this design is the combination of the large radiating surface with a low watt surface density and the chimney effect of the tube.

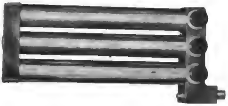


FIG. 42.—TUBULAR TYPE, LOW-TEMPERATURE AIR HEATER.

FIG. 43.—AIR-HEATER, CARTRIDGE UNIT TYPE.

FIG. 44.—GENERAL ELECTRIC LUMINOUS RADIATOR.

It is manifest that, while all electric air heaters may be said to give 100 percent efficiency, the *practical* efficiency, which is judged by the uniform and effective distribution of the heat in the room, can be obtained only by passing a relatively large volume of air over the heating surfaces, and raising it only a few degrees above the temperature of the room. The oftener the total volume of air in the room passes over the surface of the heating source, and the less temperature difference between the outlet and inlet, the more efficient is the heating system.

Three distinct forms of heating elements are used by the General Electric Company. The cartridge unit consists of a thin tape of special resistance metal, wound edgewise, insulated with a fireproof cement and then inserted in a mica-lined brass tube capped with a cement plug through which the leading-in wires are brought. The quartz enamel unit is made up of a resistance wire wound in a coil of small diameter, which is then coiled into the form of a flat spiral, with mica insulating strips between its convolutions, and held against a layer of quartz grains imbedded in enamel on the bottom of the heater. Both of the foregoing heating units are practically infusible and indestructible, but can be readily replaced if damaged by accident. Great care has been taken in the design of the heating devices to insure the most efficient application of the heat, and at the same time to give proper radiating surface, so that nearly all the apparatus may be left in circuit indefinitely without fear of burn-out. (See Fig. 33.)

The third form of heating element is the tubular resistance, which is used in the tubular air heater already described. This resistance, while designed only for comparatively low temperatures, is one of the cheapest and best forms for air heaters up to a maximum of 600 or 700 degrees F., or with a density of 2 or 2½ watts per square inch. It was first developed by the General Electric Company for rheostat work, and particularly the heavy service of the railway rheostat. It consists of a tube of asbestos wound on a mandrel, the tube supporting a single layer of resistance wire closely wound, but with turns not touching. The tube is then impregnated with a fire-proof insulating compound, which gives the asbestos considerable stiffness and forms a protecting coat over the resistance wire.

REGULATING THE HEAT DELIVERED BY ELECTRIC HEATING APPARATUS.

The favorite method is similar to that described in connection with the glow lamp radiator. The heating elements are arranged inside the apparatus, in such a manner that either each element individually, or groups of elements, can be switched in and out at will. The usual arrangement is, for heating appliances, the heating elements are connected in parallel between what are practically two bus-bars, connected to the supply service. There is a main switch to disconnect the whole appliance, and there are subsidiary switches to connect and disconnect either individual elements, or groups of elements, from the bus-bars.

FIG. 45.

FIG. 46

PROMETHEUS REGULATOR DETAILS.

The British Prometheus Company has another system of regulating for some of their apparatus, which is something on the lines of the regulator of the tramway service. There is a sleeve of approximately square section, as shown in Fig. 45, with conductors on the insides of the four faces, connected to the heating elements. The corresponding fitting (Fig. 46) consists of a solid piece of insulating material of square section, carrying conductors on its faces, the conductors being connected to flexible cords, to which the regulator is attached. It is arranged that the conductors on the male portion, when making connection with certain conductors on the female portion, allow full, three-quarters, one-half or one-quarter of the current strength to pass as may be desired, the arrangement being made by connecting the different elements in the heating appliance in different order. Thus, for full heat, all the elements will be connected in parallel. For half heat, two sets will be connected in parallel, afterwards being connected in series in each parallel, and so on, for the other heats.

Other methods of varying the heat include that shown in Fig. 47, which is adopted by Messrs. Isenthal, of London, which is somewhat similar, though different in form, to that of the Prometheus Company. The heating apparatus has three projecting pins as shown, and the connecting pipe from the supply service has three plug holes. When the three plug holes are on the three pins, the full current is passing, and the full heat is liberated. When the two plug holes on the left engage with the two pins on the right, the medium current is passing, and

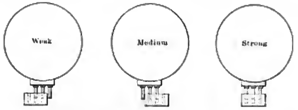


FIG. 47.—ISENTHAL METHOD OF REGULATING WITHOUT SWITCHES.

when the two plug holes on the right engage with the two pins on the left, a weak current is passing. The strength of the currents under this arrangement are as one, two and three. The three-hole plug is wired with twin wire, one of the twins being connected to the center plug hole, and the other to the two outside plug holes.

The Prometheus Company, of New York, has a somewhat similar arrangement for regulating the heat in certain cases. There are three pins on the heating apparatus, and there are three terminals on porcelain holders, connected to three conductors of a flexible cord. The three terminals on the flexible cord are colored, one red and the others black. By different arrangements of the terminals by engaging the red terminal and the black terminals with different pins, different heats are provided.

THE QUANTITY OF HEAT LIBERATED IN ELECTRICAL HEATING APPARATUS.

Referring to the formula, H is given in watts, when E is given in volts, C in amperes, and R in ohms; these being, as marine engineers know, the units of electrical power, pressure, current and resistance. The watt is the unit of power or the rate of doing work, and it will be familiar to engineers from the fact that 746 watts equal one horsepower. Work is done at the rate of one watt, when a current of one ampere passes with a pressure of one volt, or the equivalent. Thus, in the ordinary 16-candlepower incandescent lamp, working with a pressure of 100 volts, and taking a current of 0.6 ampere, the electrical energy expended in each lamp equals $100 \times 0.6 = 60$ watts.

Coming to the heat question, each watt liberates 0.0568 British thermal unit per minute, or 3.41 British thermal units per hour. These figures are derived from the figures already given, showing that the heat unit equals 17.58 watts. It is claimed, by makers of electrical heating apparatus, that the whole of the electrical energy delivered to the apparatus, whether it be in the form of the lamps that have been described, or any one of the resistance materials mentioned, is converted into heat; and therefore, where an electrical heating apparatus is employed to heat a room, the whole of the electrical energy is applied in heating the air and objects in the room. The writer mentions the claim, and so far scientists appear to have assumed that the principles upon which it is based are correct.

It is assumed by scientists that every form of energy, when transformed from the state in which it is at any moment, becomes heat sooner or later—that heat is the final form of all energy, and that the heat balance sheet is the final court of appeal upon all matters in which any form of energy is concerned. It appears to the writer that it is quite possible that other forms of energy may be liberated, when electricity is converted into something else. The question whether this does take place, or not, has not yet been examined in any way by scientists, and therefore the above statement is given with all due reserve, and the calculations which follow will be understood to be subject to that reservation. If all the electricity delivered to the heating apparatus becomes heat, the calculations are correct. In any case, it appears to the writer that any difference there may be would come within the margin which every practical engineer allows himself for possible sources of error.

The electric lamps described above, which are employed in luminous radiators, absorb, as mentioned, 250 watts each, and that would mean that $250 \times 3.41 = 852\frac{1}{2}$ British thermal units are liberated by each lamp per hour. As each British thermal unit raises the temperature of 55 cubic feet of air 1 degree F., each lamp will raise the temperature of 47,000 cubic feet of air 1 degree F. in one hour, or, say, approximately, 4,700 cubic feet 10 degrees F. in one hour, two and four lamps raising the temperature of proportional quantities of air to the same degree.

Leaving out for the moment the question of air currents and ventilation, which will be dealt with further on, it is a simple calculation to find the number of lamps required to raise the temperature of a room of a given cubical content through a given number of degrees. The temperature to which the air has to be raised varies, of course, with the climate and the seasons, but taking 40 degrees F., the figure worked to in the calculations which follow, as the increase of temperature required, this would be provided for in a room having a cubical content of 1,175 cubic feet, by one of the lamps mentioned, in one hour, on the supposition that all of the electricity is converted into heat, and that no heat passes out of the room during the time.

The above remarks apply equally to non-luminous radiators, which are made to take various quantities of electricity. Apparatus is made absorbing from 500 up to 4,000 watts, when taking their full current, and liberating from 1,700 to 13,600 heat units per hour. They are usually made to regulate the current at one-quarter, one-half and three-quarters of the full heating capacity, the heat units liberated being then from 425 to 3,400 with one-quarter, and the other figures in proportion.

(To be Continued.)

American Shipbuilding in 1908.

Returns covering the fiscal year 1908 show that 1,506 vessels of 588,627 gross tons were built. The largest previous annual output was in the year 1855, when 2,024 vessels, of 583,450 tons, were built. The steel vessels built in the year just ended numbered 142, of 417,167 gross tons (average, 2,938 tons), compared with 131, of 366,517 gross tons (average, 2,798 tons), built in 1907. The record for steel construction was broken in both these years. Of these totals for steel vessels the Great Lakes accounted for 75 of 304,379 tons in 1908, and 47 of 238,713 in 1907.

Of the 142 steel vessels built in 1908, 85 exceeded 1,000 gross tons each. Of these 55 were built on the Great Lakes, the largest being the *William M. Mills*, of 7,962 tons, and 30 were built on the seaboard, the largest being the *Columbian*, of 8,579 tons, built at San Francisco for trade to Hawaii. Four ocean sailing vessels exceeding 1,000 tons each were built during the year, the largest being the *Edward J. Lawrence*, of 3,350 gross tons. The tonnage built in 1908 was entirely for domestic transportation, no vessels exclusively for foreign trade having been launched in the United States.

THE COMBINATION SYSTEM OF RECIPROCATING ENGINES AND STEAM TURBINES.*

BY HON. C. A. PARSONS, C. B., F. R. S., D. SC., M. A., AND R. J. WALKER.

In the early years of steam turbine design and development it became apparent that the turbine engine was capable of economically dealing with ratios of expansion far beyond the reach of any reciprocating engine, whose limitations in this respect had been experimentally determined by many investigations.

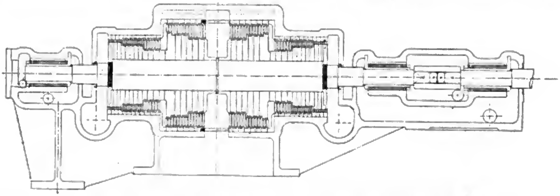


FIG. 1.—FIFTY-HORSEPOWER LOW-PRESSURE TURBINE FOR ATMOSPHERIC PRESSURE, DESIGNED IN 1889.

In 1889 the first condensing turbine, of about 100 horsepower, was designed for an expansion ratio of 100 by volume, the expansion being effected in two turbines of the double-parallel flow type, the low-pressure turbine (Fig. 1) taking steam from the exhaust of the high-pressure at atmospheric pressure, and expanding it down to 1 pound absolute. The striking feature presented by this design was the very high estimated efficiency of this low-pressure portion. A separate low-pressure turbine was not, however, actually constructed until some years later.

In 1894 a patent was taken out for the "combination" of a reciprocating engine with a steam turbine, whose object was "to increase the power obtainable by the expansion of the steam beyond the limits possible with reciprocating engines."

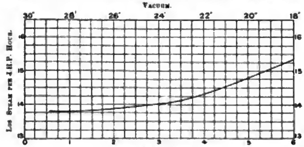


FIG. 2.—EFFECT OF VACUUM ON STEAM CONSUMPTION OF 200-HORSEPOWER TRIPLE EXPANSION RECIPROCATING ENGINE.

The previous treatment of the steam is, of course, immaterial, provided that its condition of pressure and wetness on reaching the engine are known.

The first instance of a separate turbine worked from the exhaust of other turbines was in the *Turbinia's* machinery in 1897—the pressure at entry of her low-pressure turbine was about 9 pounds absolute, and the exhaust 1 pound absolute. The slip ratio of her three shafts showed that the low-pressure turbine developed about one-third of the total horsepower obtained from the steam at 160 pounds pressure, agreeing closely with calculations.

In the year 1902 the combination of reciprocating engines exhausting into turbines was first put to a practical test in His Majesty's destroyer *Velox*. In this vessel two small reciprocating engines were fitted for cruising purposes, of such power that, in combination with the main turbines, they would give an economical consumption at speeds of 11 to 13 knots, the usual cruising speeds at the time the *Velox* was built.

The arrangement of machinery consisted of one main high-pressure and one low-pressure turbine on each side of the vessel, each driving a separate shaft, or four shafts in all. The two small reciprocating engines were coupled at the forward end of each of the low-pressure turbines. For speeds up to about 13 knots, steam was admitted to the two reciprocating engines, and expanded down to about atmospheric pressure; it then passed through the high-pressure, and thence through the low-pressure turbines to the condenser. This combination gave excellent results at these cruising speeds. For speeds above 13 knots, however, the reciprocating engines had to be cut out and steam admitted to the turbines alone. With the advance of naval efficiency, the cruising speeds of war vessels

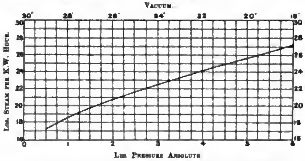


FIG. 3.—EFFECT OF VACUUM ON STEAM CONSUMPTION OF 1,000-KILOWATT TURBO-GENERATOR.

have been increased, and in vessels subsequent to the *Velox* additional high-pressure turbines have been fitted, an arrangement which permits of good economy over a wide range of cruising speeds.

It may be said that perhaps the most important field for the combined system of machinery as applied to marine propulsion is for those installations where the designed full speed of the vessel falls below the range suitable for an all-turbine arrangement, the reciprocating engine working in the region of pressure-drop where the conditions are best suited for it, and the turbine utilizing that portion of the expansion diagram which the reciprocating engine is not able to utilize efficiently. It is generally well known that an all-turbine arrangement has not been advocated by us for ships where the designed speed falls below 15 or 16 knots, excepting in some special cases, such as yachts; and for vessels of moderate or slow speed the combination system of machinery appears to be eminently suitable.

* Read before the Institution of Naval Architects, April 9, 1908.

In a good quadruple reciprocating engine, the steam is expanded down to the pressure of release, about 10 pounds absolute, and gains in economy as the vacuum is increased up to about 25 or 26 inches, whereas, in a turbine, it is possible to deal economically with very low-pressure steam, and to expand this low-pressure steam to a low absolute pressure corresponding to the highest vacuum obtainable in turbine practice.

Figs. 2 and 3 show the effect of vacuum upon steam consumption as the result of tests carried out on a reciprocating engine and steam turbine, respectively, from which it will be noted that, while the curve for the reciprocating engine gives the minimum consumption at between 25 and 26-inch vacuum, the curve for the turbine continues to fall as the vacuum increases.

In a certain quadruple expansion reciprocating engine exhausting to condenser direct, the maximum energy realizable, from 200 pounds to 26 degrees vacuum, with point of release at 10 pounds, is 256 British thermal units. The additional area which the reciprocating engine cannot efficiently utilize, but which can be used in a turbine, is 73 British thermal units. In the combination of triple expansion reciprocating engine exhausting to turbine and thence to condenser, the maximum energy realizable in the engine from 200 pounds to 8 pounds absolute, with point of release at 13 pounds, is 219 British thermal units. The energy available for the turbine, from 7 pounds to 28-inch vacuum, receiving wet steam from the reciprocating engine, is 100 units. The total energy of the combination is 319 British thermal units. Theoretically, the total energy of combination is 24½ percent greater than that of the quadruple engine. It is estimated that a large portion of this additional energy can be realized by the combined system in the shape of increased power to drive the vessel, or, on the other hand, increased economy. The theoretical figures are computed on the basis of adiabatic expansion throughout.

In a combination system, the most suitable initial pressure for the turbine, or the dividing line between the reciprocating engine and the turbine, will greatly depend upon the conditions of service of the particular vessel taken. The reciprocating engine, or engines, could be designed to exhaust at a pressure of between 8 pounds and 16 pounds absolute, or even at a slightly higher pressure, if necessary, to meet the conditions required. From an estimate of the theoretical efficiency under the various conditions of pressure as set forth in the following table, it would appear, apart from any practical considerations, that there is nothing to choose between an initial pressure at the turbine of 7 pounds and 15 pounds absolute, any pressure within this limit appearing to give a most economical result. The assumption is for 200 pounds absolute steam pressure at the reciprocating engine, and 28 inches vacuum at the condenser:

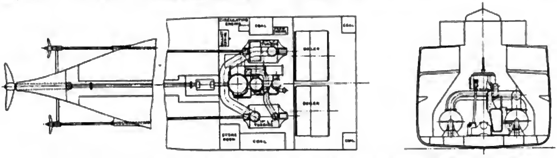


FIG. 4.—ARRANGEMENT OF COMBINATION OF TRIPLE-EXPANSION ENGINE WITH TWO LOW-PRESSURE TURBINES IN SERIES.

Initial Pressure, Turbine.	Reciprocating Engine, Back Pressure.	Theoretical B. T. U. Per Pound of Steam		
		Engine.	Turbine.	Total.
15	16	178	142	320
12½	13½	189	131	320
7	8	218	100	318

In the case of a vessel which runs on service continually at or about her designed full speed, an initial pressure of about 7 pounds absolute at the turbine appears most suitable. In a vessel which does part of her running at the designed power, and part at a considerably reduced power, it is desirable to design the turbines so that the initial pressure would not fall below 7 pounds absolute when running under the lower conditions of power.

It might be of interest at this stage to consider the disposition of the turbines in combination with reciprocating engines on board ship. The arrangement of the turbine, or turbines, depends greatly upon whether the vessel is to be fitted with single or twin-screw reciprocating engines. With a single reciprocating engine, one turbine, two turbines in "series," or two turbines in "parallel" could be fitted, each turbine driving a separate shaft, in addition to the reciprocator shaft. With twin-screw reciprocating engines, an arrangement of one turbine in the center of the vessel, two turbines in "parallel," or two turbines in "series," could be adopted. The arrangement which seems to commend itself generally to shipowners and builders, where twin-screw reciprocating engines

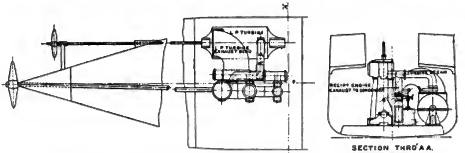


FIG. 5.—ARRANGEMENT OF COMBINATION OF ENGINE WITH ONE LOW-PRESSURE TURBINE.

are fitted, is the arrangement with the turbine on the center shaft.

In 1901 and the two or three following years, alternative schemes were prepared from time to time. Fig. 4 shows an arrangement which was prepared in 1901 of a single reciprocating engine in combination with two low-pressure turbines in "series." The indicated horsepower of this proposal was 1,500, speed 11½ knots, and loaded displacement 5,300 tons. Fig. 5 shows another arrangement of one reciprocating engine, and a turbine on one side of the vessel. The indicated horsepower of this vessel was 1,200 total, and the speed 10 knots.

The turbines in each proposal were designed for about 25 percent of the power, and the reciprocating engines for the remainder, the turbines taking the steam from the reciprocating engines at 7 pounds absolute pressure. It was estimated that the combination, as applied to cargo vessels, would be about 15 to 20 percent more economical than the ordinary triple expansion engine usually fitted to this class of vessel.

Owing to the rapid development of the turbine industry for high-speed work, and the attention which was, in consequence, paid to this branch of the business generally, the development of the combination system fell more into the background than its merits and the wide scope of its application would seem to have deserved. About two years ago, at the suggestion of Sir William White, designs were prepared of a combination system as applied to the intermediate type of liner of moderately large power and speed, and since that time numerous designs have been prepared for various types of vessels of speeds ranging from 13 to 16 knots.

By the courtesy of Swan, Hunter & Wigham Richardson, who, for a considerable period, have taken much interest in this combination of machinery, the figures in the second table are given of the comparative sizes of engines, power, etc., of the "combination" as compared with twin-quadruple engines, for a proposed steamer of 490 feet in length, 13,600 tons displacement, 7,200 indicated horsepower, and 15½ knots speed.

In the combination proposals set forth in columns B and C in the table, it may be mentioned that in this particular inquiry the shipowners wished to have the advantage of the additional power and increase in speed of the vessel on the same coal consumption as for the twin-quadruple engines. In some instances an increase in speed might not be desired, in which case the boilers and engines could be reduced in size by the estimated amount of saving in consumption, so that the total indicated horsepower of the combination did not exceed that required with twin quadruple engines. This would considerably reduce the total weight of machinery, and also the bunker capacity for a given distance. This saving in the weight of the machinery and in the bunkers would enable the vessel to carry an equivalent addition in deadweight cargo. Then, again, if we take the indicated horsepower at 8,300 for the combination, and assume that quadruple engines and boilers were required to give an equivalent power, the extra total weight of machinery would be, roughly, 160 tons, in addition to an increase of about 12 percent in coal consumption for the same power.

Fig. 6 shows an arrangement of twin-quadruple engines corresponding to particulars given in column A (twin-quadruple expansion reciprocating engines) of the table. Fig. 7 shows an arrangement of twin triple expansion engines, working in conjunction with two low-pressure turbines, as set forth in column B (twin three-cylinder triple expansion engines, with two low-pressure turbines in parallel), the reciprocating engine on each side exhausting into a turbine. By this arrangement an independent set of engines is obtained on each side of the

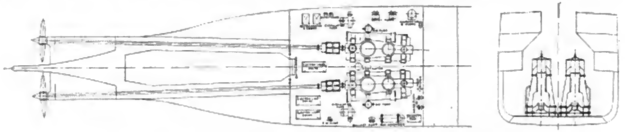


FIG. 6.—GENERAL ARRANGEMENT OF TWIN-SCREW QUADRUPLE EXPANSION ENGINES OF 7,300 HORSEPOWER.

	A.	B.	C.
Cylinders of reciprocating engines	25, 36½, 51½, 75	27, 42, 66	26, 39, 46, 46
Stroke of pistons	55	48	42
Revolutions of reciprocating engines	84	85	100
Piston speed of reciprocating engines	770	680	700
Boiler pressure	213 pounds	213 pounds	213 pounds
Estimated pressure at highpressure receiver	200 pounds	200 pounds	200 pounds
Initial pressure, absolute, turbines		7 pounds	7 pounds
Vacuum at condenser........	26 inches	28 inches	28 inches
Steam consumption, per hour, main engines only	95,000 pounds	95,000 pounds	95,000 pounds
Indicated horsepower, reciprocating engines	7,300	6,300	6,300
Estimated equivalent indicated horsepower of turbines		2,000	2,000
Total indicated horsepower......	7,300	8,300	8,300
Percent increase in power		13.7	13.7
Estimated speed of ship	15.8 knots	16.2 knots	16.2 knots
Steam consumption, per total indicated horsepower per hour, main engines	13 pounds	11.45 pounds	11.45 pounds
Steaming weight of engines and boilers (reciprocating engines)	....	1,430 tons	1,455 tons
Weight of turbine installation ...		65 tons	70 tons
Total steaming weight......	1,560 tons	1,495 tons	1,525 tons
Pounds per total horsepower.....	479	403	412
Revolutions of turbines........	....	480	320

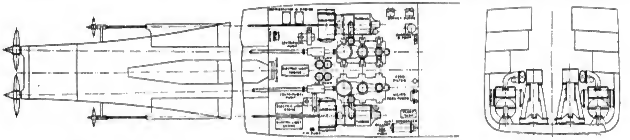


FIG. 7.—ARRANGEMENT OF COMBINATION OF TWIN-SCREW ENGINES AND TWO LOW-PRESSURE TURBINES IN PARALLEL; 8,300 HORSEPOWER.

vessel. Fig. 8 shows an arrangement of four-crank triple expansion engines and one low-pressure turbine, as set forth in column C (twin four-cylinder triple expansion engines with one low-pressure turbine).

In arrangements shown in Figs. 7 and 8, for maneuvering in and out of port, suitable arrangements are made for changing the flow of steam of the low-pressure cylinder exhaust of the reciprocating engine from the turbine to the condenser. This can be done in two or three ways. One method is to have an ordinary change valve of the piston type, or ordinary double-beat spring loaded valve actuated by links, connected to the weigh shaft of the main engine, which would automatically change the flow of steam to the condenser when the engine was reversed. With this arrangement, when going ahead on one side of the ship, the steam from the reciprocating engine would flow through the turbine; but there does not appear to be any objection to this, even if we consider the twin-screw reciprocating arrangement with a single turbine on the center shaft. It might be rather an advantage, than otherwise, to allow the steam from the engine going ahead to pass through the turbine, as the center propeller revolving would accelerate the feed of water on the rudder, and augment the turning power of the vessel. Figs. 9 and 10 show such arrangements.

Another method would be to work these valves independently of the main engines, actuated by a hydraulic engine, or by an ordinary steam-driven reversing engine. With this arrangement the low-pressure turbine would be cut out altogether, and the reciprocating engine would exhaust to the condenser, whether going ahead or astern during maneuvering.

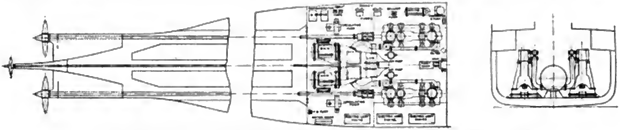


FIG. 8.—ARRANGEMENT OF TWIN-SCREW ENGINES AND ONE LOW-PRESSURE TURBINE; TOTAL HORSEPOWER, 8,300.

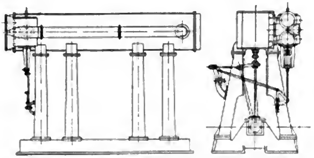


FIG. 9.—ARRANGEMENT OF PISTON TYPE CHANGE VALVES BETWEEN RECIPROCATING ENGINE, TURBINE AND CONDENSER, IN COMBINATION SYSTEM WORKED FROM MAIN ENGINE.

Enough has perhaps been said as to the general arrangement and estimated economy obtainable in the combined system, and now it may be of interest to refer to the general application of the system.

The development of the combination is already rapidly taking place on land, where the exhaust steam from non-condensing engines, especially the winding engines of collieries, and rolling and mill engines, is being utilized in low-pressure condensing turbines. There are, at the present time, some twenty-four of these installations of the Parsons type delivered, working and under construction, ranging from 125 to 1,250 kilowatts, and representing a total brake horsepower of about 17,000. In most cases the exhaust steam is supplied to the low-pressure turbine at 15 pounds absolute pressure, and a vacuum of 28 inches, and under such conditions about an equal amount of power can be obtained from the turbine as from the non-condensing reciprocating engine; thereby doubling the power of the plant without any further consumption of fuel. From several tests made with these exhaust turbines on land, a consumption of about 34 pounds per kilowatt-hour can be obtained in a 500-kilowatt machine, with an initial pressure of 15 or 16 pounds absolute, to 28-inch vacuum.

In regard to marine installations, the combination is being fitted to a large vessel at present under construction at the works of Harland & Wolff, for the Montreal trade of the Dominion Line. The arrangement of machinery in this vessel is substantially as described in column C of the table previously referred to, viz.: twin four-crank triple expansion engines, exhausting into one low-pressure turbine driving the center shaft.

William Denny & Brothers are also at present building a vessel for the New Zealand Shipping Company, which is being fitted with the combination system of twin triple expansion engines and one low-pressure turbine. This vessel is an exact repeat of two other vessels which Messrs. Denny have built for the same owners, except as regards type of engines.

In addition to the above, the Turbinia Works, in conjunction with Alexander Stephen & Sons, of Glasgow, are fitting the combination system to the yacht *Emerald*. In this vessel, which was one of the first to be fitted with an all-turbine arrangement, it is intended to make some modifications to the existing arrangement of machinery by introducing a reciprocating engine on the center shaft in lieu of the high-pressure turbine at present in the vessel. This engine will be of the high-speed inclosed self-lubricating type, and is now being constructed by J. S. White & Company, Cowes. It is designed to exhaust into the two low-pressure turbines at about 15 pounds absolute pressure, the cylinders of the engine being 12½, 19 and 30 inches in diameter, with a stroke of 18 inches, and revolutions about 350 per minute. It is expected that this vessel will be ready for trials in about four months' time.

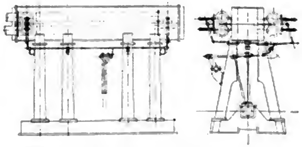


FIG. 10.—ARRANGEMENT OF DOUBLE BEAT CHANGE VALVES BETWEEN RECIPROCATING ENGINE, TURBINE AND CONDENSER, IN COMBINATION SYSTEM WORKED FROM MAIN ENGINE.

THE PIECES ARE GLUED TOGETHER AND EDGES ROUGHLY REMOVED BY A HATCHET. THE HUB IS INTEGRAL WITH THE BLADES.

THE LAYING OUT OF PROPELLER WHEELS.

BY CHARLES S. LINCH.

PATTERN MAKING.

We will now describe briefly the method of building up the pattern. The description, with the accompanying photographs, will make the subject clear, ,but to enter into every detail would far exceed the limits of these columns. We will take for illustration the propeller shown in Fig. 7. This wheel is 10 feet 6 inches diameter; 14 feet pitch; four blades.

The patternmaker first lays off on a large board to full size the view looking down on the wheel, as shown, and proceeds to lay down the sections of blades at their proper angle. This view is then divided up into a number of sections to suit the thickness of lumber, which is purely arbitrary. In this case the sections are 2½ inches thick. Having fixed on this detail, we proceed to get out a template, as shown in Fig. 8. On this template we set off points corresponding to the divisions, as

THIS GIVES A CLEAR INSIGHT INTO THE MANNER OF BUILDING UP THE SECTIONS. THE DRIVING FACE IS FINISHED, BUT THE BACK AS YET UNTOUCHED. THE BATTEN IS SPRUNG IN ON THE FACE.

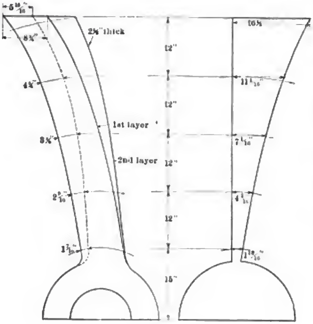


FIG. 8.

DRESSING DOWN FILLET CONNECTING BLADE AND HUB.

shown on Fig. 7. Through these points arcs are struck, as shown. It will be observed that the section of hub enters every piece that goes into the pattern, and hence forms an integral part of same, which is superior to doweling, gluing or nailing it in place. The number of pieces in this blade, as will be seen by the photographs, is eleven. Each piece is cut from the

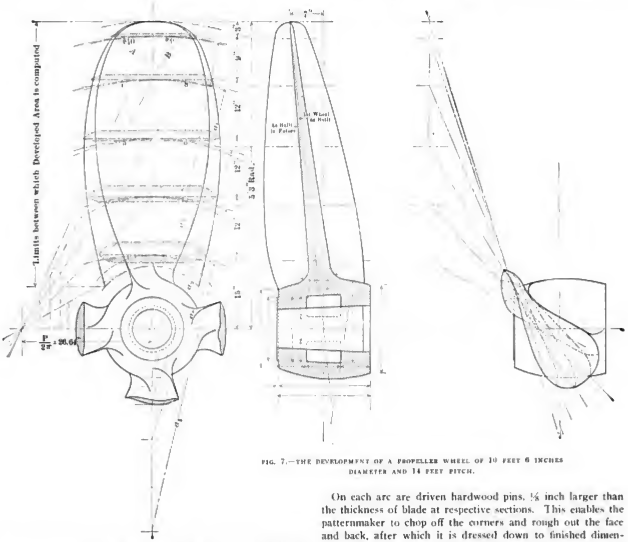


FIG. 7.—THE DEVELOPMENT OF A PROPELLER WHEEL OF 10 FEET 6 INCHES DIAMETER AND 14 FEET PITCH.

template shown. After the pieces are cut out they are glued up, as shown in the photograph. Now, on each of these arcs, as the pieces are in position, we have the cylinder intersecting the screw surface.

On each arc are driven hardwood pins, ⅛ inch larger than the thickness of blade at respective sections. This enables the patternmaker to chop off the corners and rough out the face and back, after which it is dressed down to finished dimensions. In photographs are shown the edges being reduced, and the driving face worked to finished dimensions. This is finished before the back of the blade is touched. We now see that the intersections of these cylinders are helices. Further,

THE BLADE STANDING ON THE HUB, WITH BATTENS SPRUNG IN DEFINING BLADE EDGES. THE DIMENSIONS FOR CHECKING SHAPE OF BLADE ARE TAKEN BETWEEN THESE. THE TWO VIEWS AT RIGHT ARE OF THE COMPLETED PATTERN OF ONE BLADE.

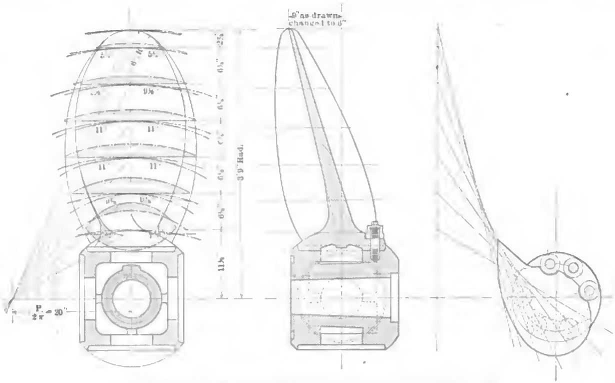


FIG. 9.—THE DEVELOPMENT OF A PROPELLER WHEEL OF 7½ FEET DIAMETER AND 10½ FEET PITCH.

we see that the length of blade is small compared with the pitch. We also note that these curves are elliptic arcs. This can be proved by drawing these arcs full size and laying them down on the pattern, showing coincidence throughout. After the face has been finished, the back is next worked down, after which the hub is brought down to dimensions. In this method of building the pattern we observe that the fillets are formed in the piece, which again is superior to fitting the fillets after the hub and blade are finished.

As noted, after the face and back have been brought to the

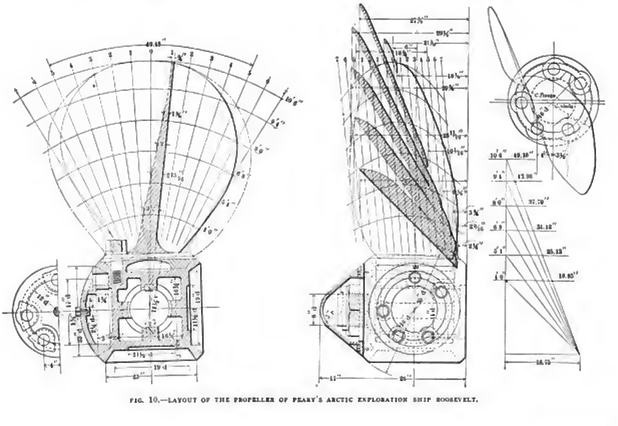


FIG. 10.—LAYOUT OF THE PROPELLER OF PEARY'S ARCTIC EXPLORATION SHIP ROOSEVELT.

finished dimensions, the dimensions, as shown in Fig. 7, and marked *1, 2, 3, 4*, etc., are laid off. A batten is then sprung through these points, and the contour worked out. In this wheel, the writer laid down a full-size template of the blade, with shrinkage rule, and laid this on the pattern, with the result that it coincided throughout. The template was cut to the first radius to avoid the fillet. Accurate dimensions of the arcs, as ellipses were made and proved with the pattern, gave the same result. The propeller in Fig. 1 was treated in the same way. The dimensions from the drawing and the pattern were inserted in a table for each wheel, and the dimensions taken from the casting appended, with other data for Fig. 1, and showed uniformity. The pitch of the propeller represented by Fig. 1 was to be 12 feet 4 inches; it was 12 feet 3 inches as cast.

In determining the mean pitch it is not sufficient that three or four dimensions be read and a mean obtained. This should be computed at the radii marked on the drawing at various sections; in this case, first 15 inches, second 27 inches, etc. Then square each radius and multiply by the corresponding breadth and pitch as measured; divide the summation by the summation of products of breadth by squared radii; the result will be the mean pitch. It may seem that more refinement enters than is necessary. I can only say that too much refinement cannot be entered into in designing a wheel, or in obtaining correct information relative to the wheel, from the drawing board to the finished casting. If we ignore this point, of what use are the data inserted on the drawing?

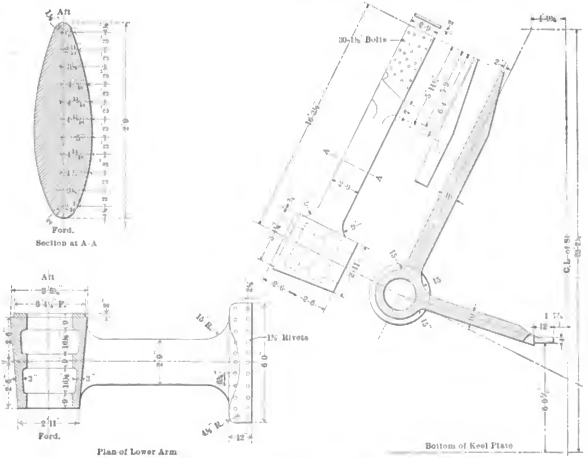
Fig. 9 is a drawing of a built-up propeller for a twin screw steamer. The photographs show the various steps more clearly than they could be described.

A FEW CONSTRUCTIVE DETAILS.

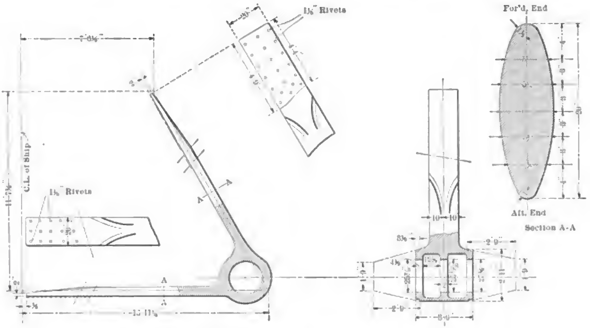
One view is given of the after strut for the propeller shaft of the *California*. Another view of this strut will be found in connection with the view of the rudder. The strut is of oval section and of cast steel, the weight of each being 32,470 pounds and the dimensions 33 by 9 inches. The center of the shaft in this strut is 9 feet 9 9/32 inches above the molded base line of the ship, and is 13 feet 1 23/32 inches out from the center line of the ship. The forward struts are also of cast steel, and weigh 18,830 pounds each, with dimensions of 20 by 6 inches. The single casting weighs 11,640 pounds, this not including the taper pieces forward and aft of the strut, or the bearing metal within the boss. The center line of the shaft at the center of the strut is 12 feet 7⅞ inches out from the center line of the ship and 9 feet 6 1/32 inches up from the base line of the ship. The center of the lower arm of the strut is horizontal, and is 8 feet 8¼ inches above the base line. The boss is 3 feet long.

Each shaft is tilted forward and down at an angle of 43 minutes 38 seconds, which makes a gradient of 0.152+ inch per foot. The shafts are likewise tilted forward and inward at an angle of 1 degree 18 minutes and 36 seconds, or a gradient of 0.274+ inch per foot. The center lines of the shafts meet at a point 97 feet 6 inches forward of the forward perpendicular of the ship, and 29.72 inches above the molded base line. Each propeller on this ship has a diameter of 18 feet, a pitch of 21 feet 6 inches, and a weight of 34,743 pounds. The material is manganese bronze. The pitch ratio is 1.194.

The after strut on the cruiser *Milwaukee* is shown in one view in connection with the rudder, and also in another separate view. This strut is similar to that of the *California*,



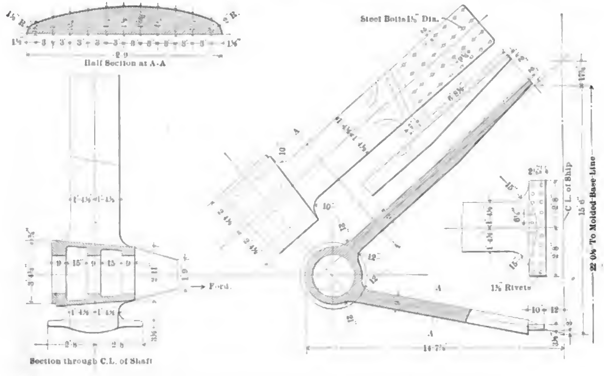
DETAILS OF AFTER PROPELLER STRUTS OF THE UNITED STATES SEMI-ARMORED CRUISER MILWAUKEE.



DETAILS OF THE FORWARD PROPELLER STRUTS OF THE UNITED STATES ARMORED CRUISER CALIFORNIA.

each of the after struts being of 31,140 pounds, oval in section, 33 by 10 inches, and of cast steel. The center of the shaft in the strut is 8 feet 4 1/32 inches above the molded base line of the ship, and 11 feet 4 15/64 inches out from the center line. The boss has a length of 4 feet.

The inclination of the shaft is a little greater than in the *California*, the forward and downward inclination being at an angle of 45 minutes 4 seconds, or 0.1573 inch per foot, while the forward and inward inclination is at an angle of 1 degree 28 minutes 44 seconds, or 0.3097 inch per foot. The center lines of the shaft prolonged would meet 38 feet 8 inches forward of the forward perpendicular of the ship, and 30.83 inches above the molded base line. The two propellers are of manganese bronze, weighing 29,583 pounds each. The pitch ratio is 1.132, the diameter being 17 feet and the pitch 19 feet 3 inches. Each propeller is located 4 feet 11½ inches



DETAILS OF THE AFTER PROPELLER STRUTS OF THE UNITED STATES ARMORED CRUISER CALIFORNIA.

aft of the center line of the after strut. The speed is 22.2 knots.

In the case of the *Mexican* and *Columbian*, the center line of the arm does not intersect the center line of the shaft, there being an offset, as shown on the drawing, of 15 inches. The center lines of the arms of the struts on the *California* prolonged meet in a point considerably offset from the center line of the shaft, as shown in the drawings. The struts of the *Milwaukee* and *Ohio*, however, have arms whose center lines prolonged meet the center line of the shaft. In the *Tacoma* again, the arms are offset, their center lines meeting outside the center line of the shaft.

SPEED TRIALS AND SERVICE PERFORMANCE OF THE CUNARD TURBINE STEAMER LUSITANIA.*

BY THOMAS BELL.

The following hourly abstract on one of the watches on the *Lusitania* brings home to one's mind the loss in steam and speed caused by cleaning fires, especially when the coal is small. It can be easily calculated from this what an appreciable increase in the ship's mean speed could be obtained from this cause alone, if the price and supply would admit of the use of some system of oil-fuel burning:

	Mean Revolutions.	Corresponding Speed of Ship.	
First hour	178	about 24 knots	24 15
Second hour	181	about 24 3 knots	
Third hour	186	about 25 0 knots	25 05
Fourth hour	187	about 25 1 knots	
Mean for watch	183	about 24 6 knots	

Regarding the observations from readings taken in the engine room on the official trials generally, it may be stated that on the measured miles the revolutions were obtained from electric records in connection with the pallograph apparatus, but on the lengthened trials they were taken from half-hourly readings of the engine-room counters. The vacuum recorded is that of the vapor in the main exhaust orifice forming the top of the condensers, and as measured by a siphon mercury gage, the readings of which throughout are corrected to correspond to a 30-inch barometer. The total quantity of feed water is obtained from hourly counter readings of the double strokes of the Weir's feed pumps, the average length of stroke and the slip or leakage of each pump being determined, both before and after the trials, by careful tests.

The consumption of steam of the auxiliary machinery is obtained by noting the amount by which the temperature of the total feed water was raised in the feed heaters, and to the amount thus found must be added the steam used in the turbo-generators, the exhaust from which was led direct to the auxiliary condensers on the official trials. As before stated, in actual service these turbo-generators exhaust into the contact heaters, and thus raise the feed temperature to about 200 degrees. These connections had to be slightly altered at the time of the trials, and, unfortunately, therefore, advantage could not then be taken of this additional source of economy.

The torque horsepower was obtained by the Denny-Johnson apparatus, and the records show that, while a propulsive efficiency of the whole installation was obtained which accorded with the original estimate, the steam consumption of the turbines themselves was very satisfactory. It need hardly be pointed out that those two, viz.: propulsive efficiency and steam consumption per unit of power, form an excellent check on each other, for whatever would unduly favor one would be at the expense of the other.

The *Lusitania* was floated out of drydock at Liverpool on July 22, 1907, and was thereafter coaled by the Cunard Company, the bunkers for the forward and after boiler rooms being filled with South Wales coal, and those of the two middle boiler rooms with Yorkshire coal.

On her return to the Clyde, on the morning of July 27, a series of progressive runs was made on the Skelmorlie measured mile, as recorded on Table I., with the ship at a mean draft of 32 feet 9 inches, corresponding with a displacement of 37,080 tons. These results are also given in graphical form in the diagram on Fig. 5, which gives curves of shaft horsepower, revolutions and slip on a common speed base. Two other most interesting curves have been added, one showing the effective horsepower determined by means of tank experiments, and the other showing the propulsive efficiency. It was intended to repeat this trial at the termination of the official trials, at a mean draft of about 30 feet. Unfortunately, however, thick weather on the morning of Aug. 2 prevented this being carried out, but the dotted curve on Fig. 5 indicates with sufficient accuracy what might have been expected.

TABLE I.

Time.	Pressures. H.P. Recr. Pounds.	Pressures. L.P. Recr. Pounds.	Vacuum at 30 In. Barometer.	Revs per Minute.	Speed in Knots.	Shaft Horsepower.	Slip of Propellers
First double run	157	5½ pounds	28 "	194 3	25 62	76,000	17 2%
Second double run	135	2½ pounds	27 9"	186 0	25 0	65,500	15 5%
Third double run	110	½ pound	28 1"	174 2	23 7	51,300	14 5%
Fourth double run	90	3½" Vac	28 1"	161 5	22 02	40,500	14 3%
Fifth double run	70	6½" Vac.	28 "	147 6	20 4	29,500	13 1%
Sixth double run	50	10½" Vac.	28 "	131 1	18 0	20,500	13 7%
Seventh double run	35	14½" Vac.	28 1"	116 1	15 77	13,400	14 6%

On the evening of the 27th the *Lusitania* proceeded on a pleasure cruise around Ireland, during which consumption trials at 18, 21 and 23 knots were carried out, and, after landing the guests in the forenoon of the 29th, the vessel returned to the Clyde, making a consumption trial at 15¾ knots *en route*, the results of these trials being given in the first four columns of Table V. After checking the draft of ship, etc., the 48 hours' full speed continuous trial was commenced at midnight. This trial consisted of two double runs on a course of 304 nautical miles between Corsewall Point and the Longships, and the results obtained are recorded on Table II. and the last column of Table V. The mean draft at starting was 32 feet 7 inches, and at the finish about 30 feet 8 inches, the mean for the run having been 31 feet 7½ inches, corresponding with a displacement of 35,600 tons.

TABLE II.

Time.	Pressures. H.P. Recr. Pounds.	Pressures. L.P. Recr. Pounds.	Vacuum at 30 In. Barometer	Revs. per Minute.	Speed in Knots.	Shaft Horsepower.	Slip of Propellers.
First run	146	2½	27 9"	188 8	26 35	70,400	....
Second run	145	2½	28 "	187 4	24 3	68,200	....
Third run	146	2½	27 9"	187 5	26 3	68,700	....
Fourth run	148	2½	27 8"	187 0	24 6	68,100	....
Mean of means	146	2½	27 9"	187 9	25 4	68,850	15%

The coal consumed in the 50 hours during which the engines were running at full speed was found by measurement of bunkers to be about 2,200 tons. This represents an evaporation of 10.1 pounds of water per pound of coal from 165 degrees temperature of feed, or 11.1 pounds from and at 212 degrees, and a consumption of coal for all purposes of 1.43 pounds per shaft horsepower per hour, with a rate of combustion of coal of 24.3 pounds per square foot of grate surface per hour. The number of stokers on watch was the same as in actual Atlantic service, and the air pressure in the ashpits did not exceed ¾ inch of water column. The port evaporators were used for 10 hours of the trial; but, as the vapor from

* Read before Institution of Naval Architects, April 9, 1908.

these was condensed in the port auxiliary condenser to which the exhaust from one set of the turbo-generators was led, they were discontinued, and the make-up feed obtained from the reserve tanks for the remainder of the time.

The third trial, recorded on Table III., which was commenced in the forenoon of Aug. 1, consisted of one full-power double run between Corsewall Point and the Chicken Rock, a distance of 59 nautical miles each way, but comparison with the dotted curve on Fig. 5 shows that the tide conditions during this trial give altogether too favorable a speed result. The mean draft was 30 feet 4½ inches, corresponding with a displacement of 34,160 tons. The vessel was then headed for Ailsa Craig, and carried out the specified six full-power runs between Ailsa Craig and the Holy Isle (off Arran). These latter, recorded on Table IV., which were run at a mean draft of about 30 feet 2 inches, corresponding with a displacement of 33,770 tons, give a very reliable record of power and speed at this draft, when compared with the 25.62 knots obtained on the measured mile at 32-feet 9-inch draft. On the following day weather conditions precluded any further trials, and the reversing trial and the steering and circle-turning trials were accordingly carried out on the vessel's passage to Liverpool on Aug. 26.

TABLE III.

Time.	Pressures.		Vacuum at 30 In. Barometer.	Revs. per Minute.	Speed in Knots.	Shaft Horse-power.	Slip of Propellers.
	H.P. Recr. Pounds.	L.P. Recr. Pounds.					
First run..........	152	2¾	28"	191 3	26 75	72,000	......
Second run........	152	2¾	28"	191 7	26 17	72,800	......
Mean...........	152	2¾	28"	191 5	26 46	72,400	18.2%

In a fast passenger liner such as the *Lusitania*, it is of the utmost importance that the maneuvering capabilities should leave nothing to be desired, and to demonstrate the possibilities of the ship in this respect, various trials were made, the most important being the following:

Stopping Trial.—The ship was run on the Skelmorlie measured mile at a speed of 22.8 knots, the average revolutions of the propellers being 166 per minute. On entering the mile, the engine-room telegraphs were rung to "full speed astern"; the ship was brought to rest in 3 minutes 55 seconds, the distance run being about three-quarters of a mile, or about six times the length of the ship. During this trial the boilers in the three after boiler rooms only were in use, and the initial pressure at the astern turbine was about 90 pounds per square inch.

TABLE IV.

Time.	Pressures.		Vacuum at 30 In. Barometer.	Revs. per Minute.	Speed in Knots.	Shaft Horse-power.	Slip of Propellers.
	H.P. Recr. Pounds.	L.P. Recr. Pounds.					
First run..........	151	2¾	28"	191 3	25 62	72,500	......
Second run........	152	2¾	28"	191 1	26 36	72,000	......
Third run..........	153	3	28"	191 9	25 31	72,000	...
Fourth run....	147	2½	28"	191 0	26 16	72,100	......
Fifth run..........	149	2½	28"	190 2	25 26	70,800	......
Sixth run...... .	149	2½	28"	191 2	25 96	71,800	......
Mean of means..	150	2¾	28"	191 2	25 77	71,910	15.3%

Circle Trials.—With the ship initially on a straight course, and the turbines running at an average speed of 180 revolutions per minute, the steering wheel was put hard over in 17 seconds. The tiller went over to 35 degrees in 20 seconds, and the vessel made a complete circle in 5 minutes 50 seconds, the average revolutions coming down at the completion of the circle to 70 percent of the rate at the commencement. The resulting circular path was approximately 1,000 yards, or four lengths of the ship, in diameter. This maneuver was made both under starboard and port helm with very closely confirmatory results.

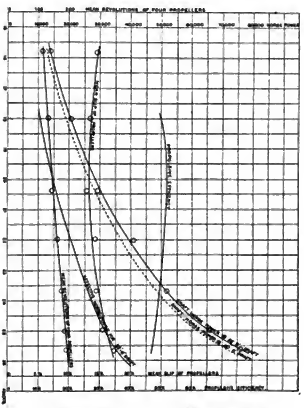


FIG. 5.—PROGRESSIVE TRIAL, JULY 27, 1907, OFF SKELMORLIE.

Going astern with the inner propellers running at a uniform rate of 136 revolutions per minute and under full helm, resulted in half circles being made in an average time of 6 minutes 45 seconds.

As important factors contributing to these very satisfactory results, it may be remarked that, following on the suggestion of Sir Philip Watts, the deadwood aft is cut away in a fashion similar to that in recent warships. The inner propellers are fairly close together, and as the rudder is of large dimensions in the fore and aft direction, the race from these propellers impinges fully upon it when any helm is used. The vessel, consequently, is very similarly circumstanced to a single screw ship, or a triple screw ship with all three propellers in action, and gets steerage way without any perceptible headway, and this feature was very noticeable during the steering trials. At first sight it would appear that the outer propellers should have

TABLE V.

Actual steam and coal consumption of main and auxiliary engines at various speeds under conditions prevailing on official trials, viz., turbo-generators exhausting to auxiliary condensers, other auxiliaries exhausting to heaters.

Shaft horsepower..........	13,400	20,500	33,000	48,000	68,850
Speed in knots	15 77	18 0	21 0	23 0	25 4
Temperature of feed water. . .	200°	200°	199°	179°	165°
Total consumption of auxiliaries in pounds per hour..	71,000	76,400	85,700	96,700	116,500
Total consumption of turbines in pounds per hour	284,500	353,600	493,300	668,300	879,500
Steam consumption of auxiliaries in pounds per turbine horsepower hour........	5 3	3 72	2 6	2 01	1 69
Steam consumption of turbines in pounds per horsepower hour .	21 23	17 24	14 91	13 92	12 77
Total steam consumption in pounds per horsepower hour........	26 53	20 96	17 51	15 93	14 46
Coal consumption in pounds per horsepower hour.	2 52	2 01	1 68	1 56	1 43
Estimated coal consumption in tons on a voyage of 3,100 nautical miles, allowing 20 tons for galleys, etc.	2,980	3,190	3,670	4,520	5,390

TABLE VI.

Estimated steam and coal consumption at various speeds, allowing for the additional auxiliary steam consumption found requisite under actual service conditions for the washing water supply, etc., with a full complement of passengers, weather conditions being as on official trial.

Shaft horsepower	13,400	20,500	33,000	48,000	68,850
Speed in knots	15.77	18.0	21.0	23.0	25.4
Temperature of feed water	200°	200°	200°	200°	200°
Total consumption of auxiliaries in pounds per hour	93,500	100,900	112,700	127,500	149,700
Total consumption of turbines in pounds per hour	284,500	353,600	493,300	668,300	879,500
Steam consumption of auxiliaries in pounds per turbine horsepower hour	6.97	4.92	3.41	2.65	2.17
Steam consumption of turbines in pounds per horsepower hour	21.23	17.24	14.91	13.92	12.77
Total steam consumption in pounds per horsepower hour	28.2	22.16	18.32	16.57	14.94
Coal consumption in pounds per horsepower hour	2.76	2.17	1.8	1.62	1.46
Estimated coal consumption in tons on a voyage of 3,100 nautical miles, allowing 20 tons for galleys, etc.	3,270	3,440	3,930	4,700	5,490

been those utilized for maneuvering purposes, as the outer shafts have about three times the spread from the middle line that the inner shafts possess. For turning with propellers alone without the help of the rudder they would have been much the more effective, but they would not have possessed any such advantage as that alluded to above in respect to obtaining steerage way without headway.

Table VI. has been compiled for comparison with Table V., to show the additional consumption of steam for auxiliary purposes under actual working conditions at sea with the ship full of passengers. This shows very clearly the demand which modern improvements make on the steam, and hence coal consumption of a large passenger vessel. An additional line has been added to Tables V. and VI. to show total coal consumption on a voyage of 3,100 nautical miles at the various speeds and under the different conditions.

With reference to the third voyage west, from Nov. 2 to Nov. 8 of last year, thanks to the courteous permission of the chairman of the Cunard Company, the leading particulars of the official engine-room log are summarized in Table VII. Regarding the mean draft of the vessel at sea, it may be remarked that, after the second day out, certain of the forward tanks were gradually filled for the purpose of avoiding excessive trim, so that the mean draft on Nov. 5, 6 and 7 was approximately 32 feet, or very little more than the mean of the first pair of runs from Corsewall Point to the Longships and back. The conditions, however, were otherwise very different, for, with the exception of the 12 hours of fine weather and smooth sea from noon till shortly after midnight on Nov. 6, it was throughout the average mid-Atlantic winter weather—namely, strong winds and resulting boisterous sea. Up till midnight on the 6th, *i. e.*, for 2,176 out of a total of 2,781 nautical miles, the mean speed works out at 24.65 knots; but, unfortunately, early on the 7th the wind freshened, gradually increasing to a furious southwest gale, which reached its height about 4 P. M., and reduced the average speed for the last 24 hours below 23 knots, and thus brought down the mean

TABLE VIII.

Date—1907	Length of Steaming Day. Hrs. Min.	Distance Run, Nautical Miles.	Speed, Knots.	Total Distance Steamed.	Total Time. Hrs. Min.	Mean Average Speed.
Noon, November 3	0 52	21	24.24	21	0 52	24.24
Noon, November 4	24 57	606	24.28	627	25 49	24.27
Noon, November 5	25 2	616	24.6	1,243	50 51	24.44
Noon, November 6	24 55	618	24.8	1,861	75 46	24.57
Noon till midnight, November 6	12 30	315	25.2	2,176	88 16	24.65
Noon, November 7	12 22	295	23.85	2,471	100 38	24.55
Morning, November 8	14 2	310	22.09	2,781	114 40	24.25

average for the completed voyage to 24.25 knots. Table VIII., giving the mean average speeds at the different stages of the voyage, shows very clearly the effect of this gale, unfortunate so far as preventing the vessel from complying with the contract conditions, but giving those connected with the ship an opportunity of thoroughly satisfying themselves as to her behavior when driving through the huge waves at about 22½ knots, without any racing of engine or sign of laboring, and dispelling the idea, current in some minds, that turbine-propelled ships do not show to advantage in heavy weather.

The following particulars of the steam consumption are given in conjunction with the figures of coal consumption set forth in Table VII. Throughout the voyage a careful record of the feed pump counters gave an average of 998,000 pounds of water pumped into the boilers per hour. Of this, about 114,000 pounds was used by auxiliary machinery exhausting into the feed heaters, 26,000 pounds by the evaporating plant supplying feed make-up and washing water, and about 6,500 pounds for steam to the thermotanks, galleys and pantries, both of which latter figures are based on data obtained from tests carried out before the vessel left the Clyde. Hence, taking the average shaft horsepower as 65,000, the steam consumption per shaft horsepower per hour works out as follows:

	Total Water.		Per Shaft Horsepower Hour.
Main turbines	851,500 pounds.	=	13.1 pounds.
Auxiliary machinery	114,000 pounds.	=	1.75 pounds.
Evaporating plant and heating	32,500 pounds.	=	.5 pounds.
	998,000 pounds.		15.35 pounds.

Average amount of coal burnt per hour for all purposes = 43½ tons.
Water evaporated per pound of coal = 10.2 from a feed temperature of 196°.
Water evaporated per pound of coal = 10.9 from and at 212°.
Coal for all purposes per shaft horsepower per hour = 1.5 pounds.
Coal per square foot of grate per hour = 24.1 pounds.

Taking a mean displacement of 36,000 tons, this represents at 24¼ knots a consumption of almost exactly 11 pounds of coal per 100 nautical miles per ton of displacement. The coal used was half South Wales and half Yorkshire, practically the same as on the official trials.

TABLE VII.

ABSTRACT OF ENGINE-ROOM LOG FOR THIRD VOYAGE WEST: QUEENSTOWN TO NEW YORK.

Date when last dry docked July 22, 1907. Mean draft, leaving Queenstown, 33 feet 7 inches. Mean draft, arriving New York, 30 feet 10 inches.

Date 1907.	Steam Pressures: Boilers. Pounds.	Steam Pressures: H.P. Recrs. Pounds.	Steam Pressures: L.P. Recrs. Pounds.	Temperatures: Hot Well.	Temperatures: Feed Water.	Vacuum.	Barometer.	Length of Day: H's	Length of Day: M's	Distance by Observation, Nautical Miles.	Mean Speed.	Mean Revs.	Mean Slip Percent.	Coal Consumed for Main and Auxiliary Engines.
Noon, November 3	170	140.0	2.3	68°	200°	28"	30.4"		52	21	24.24	182.5	16.5	40 tons
Noon, November 4	169.1	142.2	2.2	78°	197°	28"	29.7"	24	57	606	24.28	182.6	16.4	1,090 tons
Noon, November 5	167.3	140.6	2.3	78°	198°	28.2"	30"	25	2	616	24.6	182.8	15.4	1,090 tons
Noon, November 6	168.3	140.4	2.5	70°	196°	28.2"	30.1"	24	55	618	24.8	183.5	15.1	1,090 tons
Noon, November 7	168.3	138.3	2.2	72°	195°	28"	29.6"	24	52	610	24.52	181.4	15.0	1,090 tons
1.14 a.m. November 8	165.	132.5	1.5	75°	200°	27.8"	29.3"	14	2	310	22.09	174	20.2	*576 tons
Means	168	139.3	2.2	74.5°	197°	28.1"	29.8"	Total 114	40	Total 2,781	24.25	181.1	15.9	4,976 tons

* This includes all coal used till 10 a. m. on the 8th.

Summary of total coal consumed on voyage:—Liverpool to Queenstown, 408 tons. Queenstown to New York, 4,976 tons, galleys, etc. 18 tons, total coal taken from bunkers, from leaving landing stage, Liverpool, till moored at wharf, New York, 5,402 tons. Passage—Queenstown to Sandy Hook—4 days, 18 hours, 40 minutes.

THE BOSTON FLOATING HOSPITAL.

BY ROBERT CHARLES MONTEAGLE.

The Boston floating hospital for infants and small children, as it exists to-day, is the development of fourteen years of study and actual practice in the wants of thousands of little sick children. The work in Boston began in 1894, when five experimental day trips were made on a hired barge, with volunteer service only. The following year, under the same system, thirteen day trips were undertaken, and in 1896 daily trips were inaugurated. The work was then given into the hands of a board of managers—a medical staff and two paid nurses. In 1897 the barge *Clifford* was bought, and equipped to care for 150 sick infants and children, she being towed during these trips. In 1898 two wards were established for permanent patients, and a night service was organized. From 1898 to 1900 the work developed steadily, and has continued to develop until the need for a larger vessel became a necessity. In the fall of 1905 it was decided to build a new vessel. This has been done, and in August, 1906, the new vessel made her first trip.

and 10 feet 8 inches molded depth. The gross tonnage is 594. The hull is of steel, and was designed to have the most simple construction with the maximum accommodations, without regard to speed—this latter being of no moment. Her plating is 12 pounds. the sheerstrake being 18 and 20 pounds; frames, 3 by 5 inches by 11 pounds, spaced 30 inches, and bracketed to the deck beams. A number of deep floors are placed in the machinery space and at other locations. The deck beams are 3 by 5 inches by 11 pounds, placed on every frame. Three plate and angle stringer bars run the full length of the vessel under the deck beams, as shown in the midship section. Deck stringers are 30 inches by 18 pounds. The stem is a steel bar, 1¾ by 6 inches, 12 feet high.

The vessel has six watertight bulkheads, three of these being fitted with watertight doors. Fenders are placed to best advantage in case of the vessel being handled by towboats, as she was during her first season. Double rudders are fitted, operated by steam steering gear. The bottom and sides below the floor are covered with Portland cement, thick enough to cover the rivet heads. The kitchen floor is of concrete, finished on top with pure cement, as is also the floor under

THE BOSTON FLOATING HOSPITAL PROCEEDING TO SEA WITH A CARGO OF SICK INFANTS.
Photograph, N. L. Stebbins.

The new *Boston Floating Hospital* was especially designed by Burgess & Packard, Marblehead, Mass., and built by the Atlantic Works, East Boston, as a completely equipped modern hospital—embodying the results of these fourteen years of progressive study, and embracing the best thought of the brightest minds in the medical profession. The designers of this vessel had a difficult task—out of the numerous ideas suggested—to embody the worthy and reject the unworthy. In conjunction with the builders of the vessel this they succeeded in doing marvellously well. The photograph and drawings here presented are sufficient evidence of this, and should further proof be desired, a visit to the vessel—an interview with any of those connected with the work—will be found convincing. But the most convincing of all arguments is to witness the hundreds of poor, helpless, sick children and their mothers as they troop aboard, and then note the contrast in their appearance after breathing the medicine of God's pure sea air for even one day, or, in more desperate cases, for a number of days.

The new vessel, which was launched July 7, 1906, is 171 feet long over all, 165 feet on the waterline, 45 feet molded beam,

the refrigerators; 12-inch air ports are fitted. The deck is of yellow pine, 3 inches thick. The guard is formed of a thickness of 7 by 12-inch yellow pine, and a thickness of white oak, 5 by 12 inches, going completely around the vessel. Three wood keels, 24 by 12 inches, are fitted. These are formed from 12 by 12-inch and 9 by 12-inch yellow pine, with 3 by 12-inch white oak shoes.

The material for the joiner work was selected sound and free from defects and well seasoned. All moldings and corners are rounded, and all surfaces smoothed; the aim being to keep all work free from beading and crevices or depressions which would catch dust or disease germs. Especial care was taken to use nothing but well dried stock, which would not shrink and leave cracks for the shelter of dirt and the propagation of bacteria. Particular care in this respect was given to the hospital wards, and most particularly of all to the babies' food rooms. The decks are ⅞-inch matched white pine in long lengths, covered with No. 10 duck, attached with galvanized tacks. Deck beams are 1¾ by 3¼-inch yellow pine, spaced 20 inches between centers, extending full width and in one piece. There are three fore-and-aft stringers of yellow

pine, one on center line of ship, the others being spaced 10 feet off center. Stanchions are spaced about 10 feet, fore and aft. The joiner hardware is all of brass.

With a view to the efficiency of the artificial ventilating plant, great care in making air-tight work was observed in the construction of all wards and the other various rooms throughout the vessel, this latter being absolutely necessary in the case of the air-filtering rooms and the morgue. The great importance of keeping the wards free from flies or other insects was realized, and fly screens are fitted around all windows and in doorways. The outdoor ward aft is fitted with these screens completely around; all screens being made removable for storage during the winter months.

The hold contains the chain locker, crew's quarters, laundry, air-filtering room, morgue, formalin room, coal bunkers, boiler room, engine room, mothers' dining room and lecture room, kitchen and refrigerating rooms.

On the main deck are the executive office, resident physician's office, two ante-rooms, one large ward, food laboratory, sterilizing room, pharmacy, clinical laboratory, sewing and linen room, linen closet, nurses' locker and toilet room, doctors' and nurses' dining rooms, men's lockers and toilets.

On the hospital deck are six large wards, six ante-rooms, and baths and sterilizing room.

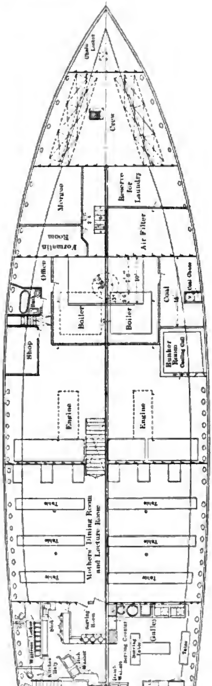
On the day patients' deck are the out-door kindergarten, nurses' resting room, assistant manager's room, the mothers' resting room, shower bath, dressing room and toilets, day patients' examination and treatment room, six staterooms for doctors, resident physician's stateroom, room for visiting physicians' staff and library, doctors' bath and toilet. On the day patients' deck is ample open air space for 150 beds and seating accommodations for the mothers.

The seven permanent wards have a capacity of 150 beds. The ward situated at the stern, on the hospital deck, is an out-door ward, where patients remain in the open air both day and night. This ward is fitted with steam heat, so that the temperature may be partially modified, should occasion require.

On the hurricane deck are the pilot house, captain's and engineer's rooms, boats, etc. This deck is not supposed to be used by the patients, but may be should occasion demand.

Forty to fifty nurses attend to the needs of the little ones during the daily trips of the vessel down the harbor. The floating hospital leaves her wharf at 9 A. M. and docks again at 4.30 P. M. Sick children not requiring permanent treatment, or those for whom room cannot be found in the permanent wards, are admitted to the day patients' deck, accompanied by their mothers, and are given the benefit of the day trip. During this time the patients receive proper diet and the attendance of doctors and nurses, who also instruct the mothers in nursing and hygiene. Many of the mothers, who may be worn out with anxiety or home burdens are greatly benefited by the fresh air, excellent food, and the knowledge that their little ones may be restored to health. Any child under six years of age, and who is not suffering from a contagious disease, is admitted. Careful examination of each applicant is made on the wharf before a patient is passed.

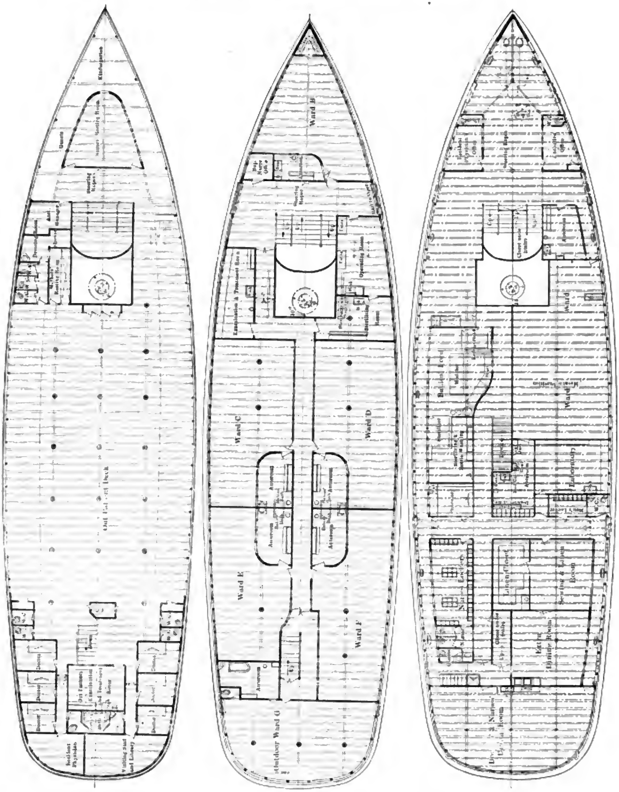
An annual post-graduate course of instruction for trained nurses, extending from July 1 to Sept. 15, is an excellent feature connected with this institution. It includes practical experience in bedside nursing of infants and small children, with all diseases incident to early life. The visiting staff of doctors lecture annually on infant feeding, premature and sickly infants, diseases of gastro enteric tract, observations of symptoms in sick and well children, defects and deformities, diseases of and care of the skin, feeble minded and backward infants, and materia medica. Diplomas are given to those who pass creditable examinations in these lectures, and who prove themselves capable in ward work. Board and rooms are



THE BOSTON FLOATING HOSPITAL—PLAN OF HOLD.

furnished by the hospital and $3.00 (12s.) per week remuneration for personal expenses and laundry is allowed.

It has been the aim of the trustees to establish the hospital upon a business basis, and this they have succeeded in doing. As this is realized by the public, funds are more freely donated for the support of this excellent work. The hospital cares for the sick children of the poor during the hot summer months.



THE BOSTON FLOATING HOSPITAL—OUT-PATIENTS' DECK; HOSPITAL DECK; MAIN DECK.

at a time when children's diseases are most prevalent, and when some of the other hospitals for infants are closed. There is no other similar institution in the world with the scope of this one. Other cities have floating hospitals, but when their equipment is considered, and their limited powers for help to poor children are compared with those of Boston's institution, one is given to wonder why other vessels of this character have not found concrete expression at an earlier date.

Statistics of the cases treated by the Boston floating hospital, all involving children under six years years of age, demonstrate the service being rendered to the community. A very large percentage of these cases are desperate when received. Children given up by physicians are often recommended to the

floating hospital as the "dernier resort." During last season fifty deaths occurred within forty-eight hours from the time of admission. They were in reality moribund when they were admitted. In the opinion of competent physicians, most of the children who were admitted to the permanent wards, and who had a fighting chance for life, were suffering from disorders under which, had they been left in their sweltering homes and unhygienic surroundings, they would have speedily succumbed.

When there is room for them, well children, whom their mothers, accompanying sick children, cannot leave at home, are permitted to make the day trip. These happy children sit out on the forward deck and play games under the guidance of a trained kindergarten teacher. The benefits of the education imparted to the mothers are incalculable. It is a fact that some ignorant parents give to their tiny offspring pickles, green apples raw onions, cheese, black coffee, strong tea, beer, wine and whiskey. Such indulgences, it is needless to state, are "tabooed" on the floating hospital, and the mothers are instructed that such food is absolutely unfit for children, and if persisted in will probably result in death.

The food laboratory of this vessel has already made very important contributions to our present-day knowledge of infant feeding. It has now attained a quality of milk which is as near perfection as possible. The ideal milk for infants is naturally that of the mother. The aim has been to imitate the lactic mixtures of human milk as closely as possible. Cow's milk, it has been found, contains about four times as much curd as does human milk. In its natural form it is therefore not a suitable food for babies. To make the milk more easily digestible has been the aim of the chemists of the Boston floating hospital, and it is one which they have solved. At the same time, perfection practically has been reached in the sterilization of milk. The Boston Board of Health sets the limit of bacteria allowable per cubic centimeter as 500,000. On the Boston floating hospital this is reduced to a bare 150. Absolute cleanliness is insisted upon, and disease germs are banished to all intents and purposes.

An interesting and highly important department of the vessel is the kitchen. The range is 7 feet long by 39 inches wide, with two fires equipped with revolving grates, and two ovens 21 by 28 inches. A double shelf 18 inches wide runs the whole length of the range. There is one 35-gallon jacketed kettle. One "bain marie," or apparatus for keeping food at a constant temperature, is of heavy copper, and contains four 10-inch porcelain soup and vegetable jars with polished metal covers, and two meat pans with copper covers. The water is heated by means of a steam coil.

There are also two 30-gallon heavy vegetable steamers, with patent water seal extending around the entire top of the steamer; one heavy galvanized iron dishwasher, 62 by 24 inches, with washing and rinsing tank, and containing patent rocker for dish basket, operated by a hand lever (the dishwasher is heated by a steam coil); one 5-gallon chocolate urn; one 5-gallon coffee urn, and one 10-gallon water urn, all furnished with gages, safety valves, muslin percolators and clean-out faucets; one milk cooler, made with double walls, and dead air space between walls. In this cooler there is a heavy cast-iron jar with porcelain lining and cover, being held in place by means of a perforated shield. There is one 7-foot triple bar pot rack, with necessary hooks and hangers; one pot sink, measuring 36 inches by 24 inches by 14 inches deep; one 14 by 10-inch glass and silver sink; seven 8-inch copper sterlizing kettles, with steam jackets and tinned linings; one hood of sheet steel extending over the range, vegetable steamers and kettle.

The vessel is equipped with a modern system of plumbing, adapted especially for its peculiar service. Hot and cold, fresh and salt water are piped throughout the vessel. The fresh water supply is taken from ten large tanks placed under the floors, eight of these being under the mothers' dining-room, and two forward of the boiler room. The drinking water system, which is also piped all over the vessel, is taken from a large tank in the engine room provided with a brine coil for cooling. The hot-water system is taken from the engine room, steam coils there furnishing the necessary heat.

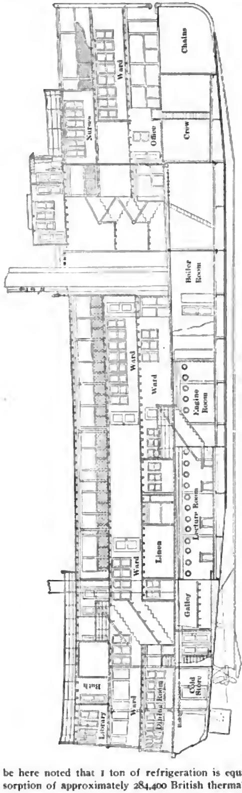
Particularly interesting and necessary features of the plumbing are the infants' baths. They are of porcelain, 24 by 20 inches by 12 inches deep, fitted with traps, hot and cold water supply and waste valves. The hot and cold water supply, as well as the waste, are operated by knee action, thus making it perfectly convenient for the nurse to have full use of her hands in attending to the child.

A complete fire system is distributed over the various decks, the steam fire pump being always connected up and ready for duty. In addition to the steam pump are two hand fire pumps connected into the line. These may be used also as bilge pumps. A complete system of bilge suction piping runs into each compartment, so that individual compartments may be pumped out in case of leakage.

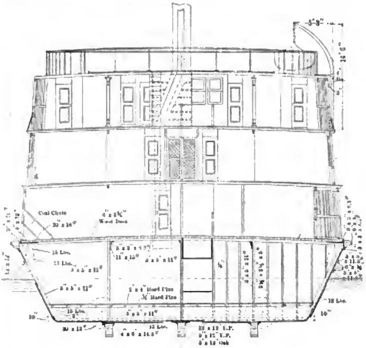
The system of ventilating the various hospital wards on the vessel is interesting. An 80-inch steel plate blower, driven by an electric motor, direct attached, and capable of furnishing 8,000 cubic feet of air per minute, takes its supply of air through a ventilator leading from the hurricane deck down to an air-filtering chamber. The inlet to the blower is connected to the outlet of this filtering chamber. After filtration the air is forced through a system of brine-cooled coils, which lowers its temperature to about 40 degrees. Precipitation of moisture in the air occurs, the cool, dry air passing continuously from the cooling chamber to the air-heating chamber. This chamber is fitted with a number of steam coils—the air passing on the outside of the coils, and having its temperature raised to about 70 degrees F. The air then passes on through a system of ducts to the various wards. The air inlets to the wards are well distributed near the ceiling, and are controlled by dampers operated by thermostats, which are entirely automatic in their operation, and exceedingly sensitive and accurate. The temperature in the wards may be controlled within 1 degree F. This perfection of regulation is dependent upon the condition required by the board of physicians, viz.: that all windows and doors in the various wards shall be kept closed.

Near the floor line the vitiated air is removed through another series of ducts, this being done by an 80-inch steel plate motor-driven exhaust fan, having its in-take connected thereto, and delivering the vitiated air into the space between the inner and outer smokestacks. The air is completely renewed in the various wards every two and one-half minutes. When it is realized that approximately 11,500,000 cubic feet of air is treated in the manner described every 24 hours, some idea of the magnitude and importance of the work is obtained. Two independent exhaust fans remove the foul air from the laundry and the morgue, and deliver it to the space between the smokestacks fresh air being taken in through suitable ventilators.

There have been installed for operation in 1908 two separate refrigerating equipments—one machine having an air cooling or refrigerating capacity equal to the melting of 65 tons of ice in 24 hours. This machine will be used for the purpose of cooling and dehumidifying the air to be introduced into the hospital wards in such a manner as to reduce its temperature to 40 degrees F., and give it a relative humidity of 50 percent, at a time when the outside temperature may range from 80 to 90 degrees F.; after which this air is reheated to 70 degrees F. by means of steam coils. This system will undoubtedly be the direct means of saving the lives of many children during the hot and sultry days and nights. It may



THE BOSTON FLOATING HOSPITAL—INBOARD PROFILE.



MIDSHIP SECTION, SHOWING SCANTLINGS OF HULL.

be here noted that 1 ton of refrigeration is equal to the absorption of approximately 284,400 British thermal units (318,500 units per ton of 2,240 pounds). The other machine has a capacity of 5 tons in 24 hours, figured on the same basis. This machine will be used for the purpose of cooling the various refrigerators now existing on the vessel, and for the cooling coils of the circulating system for drinking water, as well as for making 400 pounds of ice daily.

The 65-ton compressor is of the horizontal double-acting type, with steam and ammonia cylinders arranged in tandem. The ammonia cylinder is 14 inches diameter by 24 inches stroke, and the steam cylinder 20 inches diameter by 24 inches stroke. The engine is fitted with Corliss valve gear and a fly-wheel. The condenser is of the counter-current inner-tube type, consisting of 1¼-inch water pipe and 2-inch ammonia pipe, the ammonia passing through the annular space formed between the two pipes. All screw threads have sweated and flanged joints made up with lead gaskets. The ammonia receiver is of wrought iron 16 inches diameter by 8 feet long, and tested to a pressure of 1,000 pounds per square inch. The brine coolers are of the counter-current inner-tube type, consisting of 2-inch brine piping inclosed in 3-inch ammonia pipe; ammonia being expanded in the annular space between the pipes. The coolers are erected in sections, and provided with valves, so that any section may be cut off without interference with any other section.

The 5-ton compressor is of the vertical, inclosed, twin-cylinder type, mounted on a bedplate and direct connected to a vertical engine. The compressor cylinders are 5 inches diameter by 9 inches stroke. The engine is 8 inches diameter by 8 inches stroke. The condenser, the ammonia receiver and the brine cooler are of the same general construction as that provided for the 65-ton equipment. The exhaust steam from both ammonia compressor plants is condensed by an independent surface condenser, with its own independent air and circulating pumps.

The propelling machinery of the *Boston Floating Hospital* consists of twin-screw vertical compound engines, 10 and 18½ inches by 14 inches stroke, indicating about 200 horsepower, and fitted with Joy valve gear, cutting off at about 70 percent of the stroke. Surface condenser, a combined air and circulating pump, measuring 10 by 10 inches and 12 by 12 inches, duplicate feed pumps, sanitary pump and fire and bilge pump are fitted. Owing to lack of funds, this machinery was not installed until Mrs. L. G. Burnham presented her yacht *Pilgrim* to the floating hospital authorities. The twin-screw machinery, condenser, air and circulating pumps were quickly transferred from the *Pilgrim* to the *Boston Floating Hospital*,

where they now do excellent duty. There are two four-bladed cast-iron propellers, 5 feet 6 inches in diameter, and operated at 140 revolutions per minute.

There are two Scotch boilers, 8 feet 9 inches diameter by 9 feet long, each containing two Morison corrugated furnaces, 33 inches inside diameter, and having a combined grate surface of 45 square feet, and 1,695 square feet of heating surface (ratio 37.7 to 1). The boilers furnish steam to the main engines, electric generator, two ice machines and auxiliaries, steam windlass, steam steerer and steam heating plant, and operate at 105 pounds per square inch. The bunker capacity is 20 tons. Under full power the vessel makes about 7 knots.

The electric generator is of General Electric manufacture, direct connected, 20 kilowatts, at 110 volts and 220 amperes, with one steam cylinder 9 inches diameter by 7 inches stroke, and runs at 360 revolutions per minute. This generator furnishes light for the whole vessel and gives power to the motors for driving the pressure and exhaust blowers which furnish fresh air to wards, as well as exhausting the foul air from them, and from the laundry and morgue.

During the year 1906 about 500 permanent patients and 800 day patients were treated. The list of diseases treated in each class, giving some idea of the work being done, shows 79 distinct ailments for the permanent patients and 75 for the day patients. Omitting duplications, no less than 129 diseases were handled. The cost of the vessel, complete, was about $150,000 (£31,000).

THE MOST SUCCESSFUL DIMENSIONS OF STEAMSHIPS IN RELATION TO ECONOMY.

BY OTTO ALT, DIPLOM-INGENIEUR.

The question of the most efficient building of a technical structure—of a steamer in the present case—is to be considered the fundamental problem of technical science. It encroaches upon several provinces of human knowledge, and it may be solved only by the laws of physical science and of the science of economy. Without giving a comprehensive examination, I might give at the start as a criterion for a maximum of profit: The values produced by the object must be a maximum; the values consumed or destroyed by the object must be a minimum.

But this formula, seemingly so simple may be perfectly realized only when all co-operating factors permit an exact definition. The problem will remain unsolved while there are actions of technical or economical nature, the laws of which are unknown. New laws are discovered with every progress of development, and their numerical value will be fixed in due course. So we will be only gradually successful in reaching the desired goal.

Starting from the above basis the question is: what ship is the most profitable in a given condition of trade, and how was this result obtained? In answering this question it is necessary only to take the merchant's position, and to look at the profit and loss account, either of a joint stock company or of a private undertaking. This account for the single object might be of the following form:

Credits.

Income from freightages, forwarding of passengers, etc——B

Debits.

Operating expenses..D

Insurance premiums, bills of exchange, maintenance money, costs of stationary and necessary incidentals, costs for repairs........................b_1

Costs for fuel for the ship's power....................b_2

Interest...c

Depreciation...a

Net gain...E

Supposing the capital agrees with the book value of the ship in the first year, it results that

A (inventory of ship with machinery) $= C$ (capital stock), (1)

and, further, at the end of the first year:

$$E = B - D - (a + c). \qquad (2)$$

The gain will be found in a similar way for other years, so that results for the whole length of the ship's life will be

$$\Sigma E = \Sigma\, [B - D - (a + c)]. \qquad (3)$$

We might call this the equation of profit. The discussion of this equation (the complete connection of which we shall show later) naturally is simple. — ΣE will be a maximum, if ΣB is as high as possible, and ΣD, Σa and Σc are as low as possible.

In order to find out this maximum the laws must be known to which these quantities are subjected. All the single terms of equation (3) are not independent of one another, and to become perfectly aware of their relations a further analysis has to be made.

The value ΣB, *i. e.*, the income from freightages, forwarding of passengers, etc., for ships undertaking regularly the same route (and for simplicity we speak here only of these), is proportional to the carriage rate i per ton of cargo (under which is to be understood quite generally freight and passengers), to the carrying capacity P and to the number of voyages n, taking for the point of departure the unit of time, one year = 365 days. The number of voyages n is then:

$$n = \frac{365 - q}{\dfrac{2 \times c}{24 \times V}} = 12\, V \left(\frac{365 - q}{c}\right)$$

whereby q means the number of days per year lying in harbor in dock, etc.; c is the distance between the assumed harbors in nautical miles, and V signifies the speed of the ship in knots.

The result of these considerations is:

$$\Sigma B = \Sigma\, 12\, V \left(\frac{365 - q}{c}\right) \times i \times P \qquad (4)$$

In case the known quantities q, c, i are constant, as may be supposed for simplicity—but this is not at all necessary—the equation will become

$$\Sigma\, B = \Sigma\, k_1 \times V \times P. \qquad (5)$$

where $k_1 = \dfrac{12\,(365 - q)\, i}{c}$

The tonnage P is further defined by the following equation:

$$P = W - (W_1 + W_2 + W_3 + W_4), \qquad (6)$$

where W = displacement,

W_1 = weight of structure,

W_2 = weight of machinery,

W_3 = weight of fuel,

W_4 = weight of the fittings, stores, equipment etc.

If for brevity $W_1 + W_2 + W_3 + W_4$ is accepted to be $= \Sigma W_n$, we have, from (5) and (6):

$$\Sigma\, B = \Sigma\, [k_1 \times V\, (W - \Sigma W_n)]. \qquad (7)$$

As the profit and loss account will show, D is made up of Σb_1 and Σb_2. John Inglis has shown[1] that b_1, the costs of repairs, salaries, insurance, etc. is proportional to the gross tonnage, *i. e.*, nearly independent of all other variations. To prevent too great complication, these expenses may be considered proportional to the value of the cargo, consequently

$$b_1 = m \times i \times P,$$

or, as it may be written: in case $k_2 = m \times i$,

$$b_1 = k_2 \times P. \qquad (8)$$

[1] Transactions Institution Engineers and Shipbuilders in Scotland, 1895-1896, page 187.

The value of b_2, the cost of fuel, is proportional to the number of voyages n, to the cost of 1 ton of fuel i' and to the weight W'_3 of fuel consumed in one voyage, or, using the abbreviation:

$$k_3 = \frac{12\ (365 - q)\ i'}{c}$$

$$b_2 = k_3 \times V \times W'_3. \qquad (9)$$

The debits, therefore, are, from equations (8) and (9),

$$\Sigma D = \Sigma\ (k_2 \times P + k_3 \times V \times W'_3). \qquad (10)$$

The sum to be written off, a, is proportional to the ship's building value A, and inversely proportional to the ship's length of life t; therefore,

$$a = \frac{A}{t}$$

Supposing t to be constant, i. e., to be not influenced by variations in the weight of the ship's hull, etc., then

$$a = k_4 \times A, \text{ and } k_4 = \text{constant}. \qquad (11)$$

Up to now only those values have been considered which are of interest to the shipowner. But the ship designer has an interest, too, in the building value A. It is possible to state the interdependence of A upon other values in the following way: the building value of the structure is composed of the building value of the ship's hull, of the machinery and of the equipment. Suppose the cost per ton of the ship's hull $= i_1$, those per ton of the machinery $= i_2$ and those per ton of fittings $= i_4$, then

$$A = i_1 W'_1 + i_2 W'_2 + i_4 W'_4, \qquad (12)$$

where it may be noted that i_1, i_2, i_4 may be different in different alterations of the values W'_1, W'_2 and W'_4.

These results change (11) and (12) into

$$\Sigma a = \Sigma k_4 [i_1 W'_1 + i_2 W'_2 + i_4 W'_4]. \qquad (13)$$

The interest on the capital, c, is quickly disposed of, if supposed to be proportional to the building value (as before C is supposed to equal A); then

$$c = k_5 \times A,$$

or

$$\Sigma c = \Sigma k_5 [i_1 W'_1 + i_2 W'_2 + i_4 W'_4]. \qquad (14)$$

After having introduced for the single values characteristic values, these must be put into equation (3) in order to get a further idea of the problem. In a simple way we get:

$$\Sigma E = V\ (C_1 P - C_3 W'_3) - C_2 P - C_4\ (i_1 W'_1 + i_2 W'_2 + i_4 W'_4), \qquad (15)$$

in which C_1 has been written for Σk_1, C_2 for Σk_2, C_3 for Σk_3, and C_4 for $\Sigma\ (k_4 + k_5)$.

The total gain, equation (15), being determinative, shows a dependence on the values: cargo capacity P, weight of the ship's hull W'_1, weight of machinery W'_2, weight of fuel W'_3, weight of equipment and of stores W'_4, speed of the ship V and the unit prices i_1, i_2, i_4, as well as on the constants C_1, C_2, C_3 and C_4.

If this value ΣE is to become a maximum, then, mathematically speaking, this relation must exist:

$$\delta\ (\Sigma E) = 0. \qquad (16)$$

It would be superfluous to give the proof of the existence of such a solution, which is declared only formally by the relation (16).

The further question: how may the maximum of ΣE be surely found? consists of constructing the variations which these values may undergo, upon the basis of the laws of physical science and of the science of economy. One would start by trying to bring these variations into a form in which he might formulate the dependence of the values P, W'_1, W'_2, etc., upon a system of variables, to be considered independently. We might call these variables the *fundamental variables*.

When we have to do with materials existing in nature—either the object is manufactured of them or it comes into contact with them during its life—certain other values enter into the problem, which are constant with a determined arrangement of materials (to use a very general expression). At every change in the arrangement, such as the transition of webs to deep frames, or of a spar-deck type to a trunk-deck type, etc. the constants will have other values; but they will keep these values for all variations of the fundamental variables. These latter values may then be considered to be the *fundamental constants*. The problem may then be considered solved if it is possible to express all influences by a certain group of variables and constants.

After having sketched quite generally the method, we must come to an agreement as to which values are to be considered fundamental variables and which are constants.

A ship's physiognomy is determined to a certain degree by its geometrical form, and this form is strongly influenced by the dimensions L, B, D, to which may be added the draft d, and the coefficients of displacement δ, of load waterline α, and of midship section β. These may be considered the fundamental variables. If it is possible to prove that all influences in respect to the expression ΣE are to be rendered by these values, the group of fundamental variables does not need any supplement. As to the fundamental constants, all that is necessary will be said later on. When the variables, as well as the constants (in case alterations are undertaken in the structure), run through distinct systems of value—such that it is possible to stay in the neighborhood of the maximum ΣE—then the values W'_1, W'_2, W'_3 .... etc., by their introduction into the relation (15), enable the desired maximum of profit to be reached.

I suppose that the problem has neither been solved as yet in the generality, as given here, nor has it been formed into equations. At least, I did not find any case of this kind, in spite of exhaustive examination of the literature on the subject. Many authors, as Hamilton[5] and Inglis, confine themselves—using more empirical methods—to the inquiry into the influence of W and V (and therefore W'_3, too) on E only. Others think the maximum of ΣE to be identical with the maximum of $\dfrac{\text{useful displacement}}{\text{displacement}} = \dfrac{P}{W}$. So William Froude[6] says: "It seems a mere truism to state that the best ship for the performance of a given duty is that in which the useful displacement bears the largest proportion to the whole displacement." Examining this in connection with equation (15), and dividing both sides of the equation by W, there results:

$$\frac{\Sigma E}{W} = V \times \frac{C_1 P - C_3 W'_3}{W} - \frac{C_2 P}{W} - \frac{C_4\ (i_1 W'_1 + i_2 W'_2 + i_4 W'_4)}{W} \qquad (17)$$

and it is seen that this is not the case by any means.

Rather it might be supposed that the maximum value of ΣE is identical with the maximum of $\dfrac{P - W'_3}{W}$, when C_1 and C_3 are equal, and when the rest of the right side in equation (17) remains nearly constant. But Froude might

[5] Transactions of Institution of Naval Architects, 1898, page 256.

[6] Transactions of Institution of Naval Architects, 1874, page 148; see also A. C. Holms, *Practical Shipbuilding*, London, 1904, page 2.

not have thought of that, for he says: "The useful displacement is regarded as that displacement which remains, after deducting the dead weights of the hull as completed, with proper regard to structural strength, and of the engine power necessary to drive the ship at the required speed, and of the coal which will be consumed on the voyage." Surely Froude's "useful displacement" is very important in the question of profit, but a laying of stress upon these values will cause wrong conclusions, as is shown by the relations (15) and (17).

It is thus to be seen how the nature of the problem of profit is reflected much more generally by the examination here undertaken; which besides is not bound to the recapitulation of the variations of W_1, W_2, etc., with the fundamental variables by a mathematical-analytical process; on the contrary, the proportions of dependence can be given graphically, anyhow.

In this general composition, it is to be supposed that already measures have been taken on the shipowner's part to determine the value of P or of the number of passengers, and, besides, of the speed, upon the basis of economical conditions. These values are dependent on a whole succession of special factors, on the special development of the shipowner's interests, on commercial intercourse, on the speed of production and of consumption, on the special route the ship is to go, etc. But even then considerable variations are possible, and, above all, those which are dependent on the engineer.

Under these limitations it is possible at least to declare the dependence on the dimensions which may be shown for the single values W_1, W_2, etc., which figure prominently in equation (15), or—in case they are known already—to introduce them here in the right way.

The analysis of the value—weight of structure—will cause considerable difficulty; remembering the following influences: The form of the hull under the waterline, above the waterline (freeboard), stability (the metacentric height $G\ M$), choice of dimensions, the stresses in longitudinal and transverse dimensions, local strains, racking strains, the choice of the general principle of construction—high class—spar deck, well deck, turret-deck vessel, web frames, hold beams, choice of propelling machinery: steam engine, steam turbine, etc. A discussion of all these influences would go too far; it is required only to show the integral parts. In order to simplify the problem, to separate and to clear the influences, we divide the weight of structure—corresponding to the character of the single stresses—into the weight of the longitudinal structure $= w_1$, the weight of the transverse structure $= w_2$, the weight of structure required for the local stresses $= w_3$, and the weight of structure required by the racking stresses $= w_4$.

Therefore, the relation exists:

$$W_2 = w_1 + w_2 + w_3 + w_4. \tag{18}$$

In order to find out the weight of the longitudinal structure—including all the uninterrupted, continuous parts of the structure—we consider the longitudinal bending moment. By Vivet[4] and Alexander[5] are laid down exhaustive examinations for the standard conditions: the ship is resting on a wave, with the length of the wave $= L$ and with the height of the wave $= \frac{1}{20} L$, referring to the dependence of the longitudinal bending moment on the dimensions. Instead of the quite analytical formula given by Vivet we fall back upon the graphic data of Alexander, who, starting from the formula

$$M = \frac{W\ L}{\lambda}, \tag{19}$$

has shown the dependence of the bending moment on the remaining dimensions, in considering the value λ, to be dependent on them.

Supplying the ship's place with a box (Fig. 1), as Froude, Normand[6], Vivet and others did, the moment of resistance is

$$r = \frac{s \times D\ (3B + D)}{3} \tag{20}$$

in which terms the greater powers of s are neglected, and it results from the relation of weight that

$$w_1 = a_0\ (B + D) \times s \times L, \tag{21}$$

and from the formula of the bending moment of a straight beam:

$$p = \frac{M}{r}, \tag{22}$$

the following dependence for w_1:

$$w_1 = A_0 \times \frac{L}{D} \times \frac{B + D}{3B + D} \times M, \tag{23}$$

or

$$w_1 = A_0 \times \frac{L^2}{D} \times \frac{B + D}{3B + D} \times \frac{W}{\lambda}. \tag{24}$$

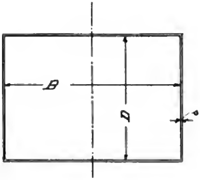


FIG. 1.

This formula is supposed to be employed in the following way: A study of strength for a choice of dimensions and of cross section of girder is to be made, and the weight of the longitudinal structure is found. According to equation (24) the constant A_0 may be calculated, which has the character of a fundamental constant. The variation of w_1 is then to be undertaken according to equation (24) for further examination. An analysis showed that the mistakes thus made are unimportant, in case L/D does not get too low; and that happened only because the hull was to be made stronger, on account of the local stresses, than the longitudinal strength required.

It has often been affirmed that the influence of δ is another important item for a ship at sea (namely, taking into consideration the forces of inertia), as it is stated by the formula of bending, enlarged by Alexander; as, for instance, Read;[7] but these examinations are yet too unsystematic and unrelated to permit a conclusion.

The weight of the transverse structure, w_2, does not permit such simple analysis; above all, because a great deal of very many different structural arrangements belong to it, the weight of which varies according to quite different laws. There are to be included in the transverse structure the frames, floors, web frames, hold beams, side stringers (in case these are fitted to assist the transverse structure), the stiffeners of longitudinal and transverse bulkheads, beams, etc.

As yet nothing is known about the dependence of the transverse structure on the dimensions (fundamental variables).

[4] *Bulletin de l'Association Technique Maritime*, 1894, page 114.
[5] Transactions Institution Naval Architects, 1905, page 116.
[6] *Bulletin de l'Association Technique Maritime*, 1892, page 2.
[7] Transactions Institution Naval Architects, 1890, page 179.

The examinations undertaken by Bruhn,[1] who treated the problem of transverse strength according to the theories of the Italian engineer Castigliano, do not even show how the transverse bending moment and the fundamental variables act and react upon each other.

To take a general case, we imagine a section of a steamer with several decks, of the length l, cut off in the vicinity of the midship section (see Fig. 2). Then different exterior forces—pressure on the bottom and sides by cargo (or the weight of parts of the machinery), hydrostatic pressure, the weight of the structure present in the respective cross section—and some other forces besides will act upon it. The principal system,[2] statically determined, will be formed then by that part of the cross section which remains after the beams (the so-called supernumerary struts) have been removed. To keep the former strength, instead of the removed beams, some structural items (see Fig. 3) are to be fixed, which introduce forces, or forces and moments, if a solid fastening exists, by strong beam knees. (See Fig. 4; both figures are taken from a tank steamer.)

First considering the moment of the exterior forces for every point of the principal system, it is necessary to state what are the conditions for the development of the greatest bending moment. But it is impossible to give general statements, authentic for all cases and types of ships, etc. It depends on the character of the cargo, on the situation and number of the longitudinal bulkheads, on the ship's condition

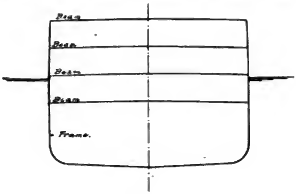


FIG. 2.

—if in dock, in calm or in rough water (cf. Bruhn). Here one case may be taken arbitrarily, and the bending moment may be derived for it; for instance, a steamer carrying oil in bulk, with a cross section like Fig. 5. The cross section may be filled with water ballast; and the draft—according to the situation of the cross section in the trough of the sea—may be h'. The moment acting on the floor in the point B is about

$$M = \frac{\gamma \times l}{8} (\beta_1 v_1 \times B^2 \times h + b^2 \times h_0) + \frac{\gamma \times l}{6} [h^2 (3h_0 + h) - (h')^2] - \beta_2 \times v_2 \times \frac{\gamma \times l}{8} \times B^2 \times h' - \frac{S \times B}{2} \qquad (25)$$

S is to be supposed to equal the third part of the difference between weight and displacement:

$$S = \frac{\gamma \times l}{3} [(\beta_1 \times B \times h + b \times h_0) - \beta_2 \times B \times h'] \qquad (26)$$

[1] Transactions Institution Naval Architects, 1902, page 270, and 1904, page 103.
[2] Compare the competent treatises on bridge building.

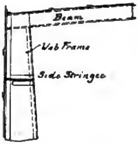


FIG. 3.

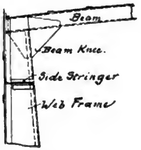


FIG. 4.

Besides the values already explained, in Fig. 5, in (25) and (26):

γ means the specific gravity of water.

β_1, β_2 mean the coefficients of midship section up to the main deck and to the draft h'.

v_1 and v_2 are coefficients, being nearly unity (and may be calculated exactly).

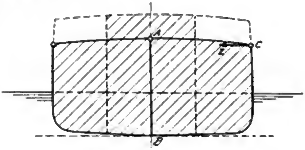


FIG. 5.

At a standard wave, for sagging condition, $h' = d - \frac{L}{32}$, in case d is the original draft. But it is easily proved that this value does not characterize the maximum bending moment at all; on the contrary, it agrees with the value of h', which is to be calculated by the relation

$$\frac{\delta M}{\delta h'} = 0 \qquad (27)$$

It results from equations (25) to (27), at all events, that a dependence may be derived from the dimensions.

(To be Concluded.)

American Warship Construction.

The decided falling off in warship construction in the United States during the past four years is clearly shown in the following table, which gives in each instance the vessels under construction on July 1:

	1904.	1905.	1906.	1907.	1908.
Battleships	13	13	9	5	4
Armored cruisers	11	9	8	3	1
Protected cruisers	2	..	3	3	1
Gunboats	2	2	..	..	..
Torpedo craft	5	2	..	..	5
Submarines	..	..	4	4	7

The displacement under construction, excluding the submarines, has fallen off from 344,859 tons in 1904 to 313,845 tons in 1905, 251,906 tons in 1906, 127,930 tons in 1907, and 93,750 tons in 1908.

INTERNATIONAL MARINE ENGINEERING

Published Monthly at

17 Battery Place New York

By MARINE ENGINEERING, INCORPORATED

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President

E. L. SUMNER, Secretary

and at

Christopher St., Finsbury Square, London, E. C.

E. J. P. BENN, Director and Publisher

SIDNEY GRAVES KOON, Editor

Branch Offices { Philadelphia, Machinery Dept., The Bourse, S. W. Anness. Boston, 170 Summer St., S. I. Carpenter.

Entered at New York Post Office as second-class matter.

The edition of this issue comprises 6,000 copies. We have no free list and accept no return copies.

Speed Trials of the Lusitania.

One of the papers before the Institution of Naval Architects in April is being republished this month (concluded from July) in the shape of a discussion of the speed trials and service performance of the Cunard steamer *Lusitania*. This is particularly apropos at the present moment, when both the *Lusitania* and the *Mauretania* are making new records on almost every trip.

In the latter half of May, the *Lusitania* ran across the Atlantic by what is known as the long route, in four days 20 hours and 22 minutes, the average speed being 24.83 knots. During the four full days of this trip the smallest daily run was 622 nautical miles, while the greatest, 632 miles, was a record, beating by 5 miles the previous record day's run, made by the same ship. A trip during the last week of May by the *Mauretania*, in which one propeller of the four was useless, showed an even more remarkable result in that the average speed, thus crippled, was no less than 24.64 knots. These runs have, it is reported, made the ships eligible for the British government subsidy, which was dependent upon a sustained round-trip speed of 24½ knots.

In the first half of June, the *Lusitania* made another record-breaking trip, during which the long route of 2,890 nautical miles was covered in four days 20 hours and 8 minutes, the average speed for the entire trip having been 24.88 knots. The best day's run during this trip was 641 nautical miles, the actual steaming period having been 25 hours 16 minutes (this variation from the 24 hours in a "land" day having been caused by the difference in longitude between the points of departure and conclusion of the day's run). The speed for this day figured out at 25.37 knots.

On her next westward trip, ending July 10, the *Lusitania* covered 2,891 miles in four days 19 hours and 36 minutes, the average speed having been 25.01 knots. One day's run of 643 nautical miles accounts for a speed during that day of 25.45 knots.

These ships are exciting such intense interest in all quarters by reason of their great size, superior appointments and especially of their high speed, that the paper before the Institution will be read with much interest wherever it is seen.

The Brazilian Battleships.

Comment has been rife during the past few weeks regarding the three Brazilian battleships under construction in England by the Elswick Works and Vickers, Sons & Maxim, Ltd. It has been stated, and vociferously denied, that the ultimate destination of these ships was Tokyo, and that the probabilities were strong against their ever flying the green and gold emblem of Brazil. Such a sale of ships under construction would be by no means novel: for in 1897 Brazil sold two cruisers to the United States; in 1903 Argentina sold two armored cruisers to Japan; in 1895 Japan bought from Chile, through Ecuador, the first protected cruiser ever built; in 1903 Britain purchased from Chile two battleships then nearly completed; and it is said that within the past few weeks Brazil has actually sold to Japan one of the torpedo boats forming part of the program of twenty-seven ships ordered more than a year ago.

Interest naturally centers, not only in the ships themselves, but in the sudden disturbance of the balance of naval power which would result should these vessels be transferred to Japan after having been almost completed for another nation. It may be remarked that the battleship strength of the Japanese navy, including ships built and building, covers eighteen vessels, with an aggregate broadside fire of 84,920 pounds (nothing under 4-inch guns being counted). The three Brazilian battleships have between them a broadside fire of 26,820 pounds, which would represent an increase to the Japanese broadside of 31.6 percent.

Japanese interests are wholly in the Pacific, and here they brush up against no one more strongly or more insistently than against the United States. The present fleet of sixteen American battleships now traversing the Pacific on a cruise, which has excited world-wide attention, has an aggregate broadside fire of 87,010 pounds, or only slightly greater than the present Japanese figures. The disturbance of the balance of power in the Pacific by the sudden addition of these three ships to the Japanese navy would thus be very startling. It is true that the American navy includes thirteen other battleships, with an aggregate broadside fire of 79,535 pounds, but these are not on the spot. Four of them are totally uncompleted and three others are undergoing extensive refits.

Regarding the ships themselves, considerable secrecy has been maintained, and such reports as have come out differ materially on important points. From best information, however, each ship appears to be of 19,250 tons and 21 knots. The main battery is given as twelve 12-inch rifles, mounted in pairs in six turrets, four turrets being on the center line and one on either beam; this gives ten guns in broadside. The secondary battery is given as twenty-two 4.7-inch guns. The aggregate broadside fire figures out at 8,940 pounds. This compares with 6,800 pounds for the *Dreadnought*, 7,234 pounds for the *St. Vincent*, 7,000 pounds for the *Satsuma*, 6,790 pounds for the *Danton*, 9,120 pounds for the *Delaware*, and 9,912 pounds for the *Nassau*.

It is thus seen that, with the exception of the new American and German ships, the Brazilians are totally without a close competitor with regard to broadside fire. Their acquisition by any power would mean an extremely effective addition to that power's first line of defense, and the outcome will be awaited with much interest.

The Combination of Engines and Turbines.

For a long time it has been recognized that the steam turbine could use expansion ratios far beyond the limits of economical operation in piston engines. This does not mean that the latter cannot be made to expand the steam down to as low a pressure as may be reached by the turbine; but it does mean that were such an engine designed and built, the size and weight of the low-pressure cylinder would be so excessive as to preclude all possibility of its being put commercially into satisfactory use. Not only this, but the immense surface thus formed would, unless extraordinary precautions were taken, give rise to a very great amount of cylinder condensation—the one source of greatest loss in the operation of the piston engine. By proper arrangement, however, of the turbine-drum diameter, and the passages between the blades, accommodation can be made to fit a suitable speed of rotation to the natural velocity of flow of the steam at these low pressures, and advantage taken of much of the great energy available from the steam in expanding through the last two or three inches of vacuum.

This peculiarity of the turbine was perhaps never more strikingly illustrated than on the westward passage of the steamship *Mauretania* at the end of May. As stated in another column, the ship made on this trip a new record of 635 nautical miles in one steaming day, and maintained an average speed over a course of 2,889 miles of 24.64 knots. This achievement was widely heralded as a great marvel, due to the fact that it was made with three, instead of the four, propellers with which the ship is ordinarily driven, one of the high-pressure propellers being temporarily out of commission. The steam, of course, was passed through simply one high-pressure turbine, and from this one to the two low-pressure turbines. The expansion was carried out to a very high degree, and such is the remarkable adaptability of the turbine to balance itself against whatever work may be placed upon it, that the total power developed in the three turbines, using approximately the same amount of steam as had previously been used in four, could not have been far different from the maximum ordinarily obtained with all four engines under operation. This fact, involving the utilization of the last few pounds of pressure above a vacuum, accounts theoretically for what, under any circumstances, must be considered a remarkable performance.

The last of the papers which we shall publish, read in April before the Institution of Naval Architects, appears in this number; and is concerned with the adoption of steam turbines for the utilization of these low pressures, after the steam has been previously passed through high-pressure engines of the reciprocating type. The main advantage of the combination lies in the ready adaptability of the piston engine to maneuvering, and more particularly to reversing.

One important point in this connection is the fact that turbines may be fitted to take up their burden at a pressure as low as that at which a piston engine is ready to discard the steam. This would involve no increase in the consumption of fuel; the only charge against it would be that of carrying the extra weight of the turbine and its accessories. If to offset this, while maintaining the same ship speed as before, we decrease the size of both engine and turbine, making the combination equal in power to the former piston engine alone, we may thereby decrease the coal consumption as compared with previous figures and propel our ship more economically from this point of view than before. The whole question is a commercial one, consisting of the balancing of improved speed or coal consumption, or both, against increased cost of installation and consequently increased fixed charges. It is a very interesting proposition, and the two or three important installations at present under way will be closely watched by engineers.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

	Tons.	Knots.		May 1.	June 1
BATTLESHIPS.					
South Carolina..	16,000	18½	Wm. Cramp & Sons..........	45.9	49
Michigan..	16,000	18½	New York Shipbuilding Co....	50.7	53.
Delaware..	20,000	21	Newport News S. B. & D. D. Co	22.8	27.4
North Dakota...	20,000	21	Fore River Shipbuilding Co ...	31.6	35.7
ARMORED CRUISER.					
Montana........	14,500	22	Newport News Co..........	98	98.8
SCOUT CRUISER.					
Salem..........	3,750	24	Fore River Shipbuilding Co...	96.4	97.1
TORPEDO BOAT DESTROYERS.					
Number 17	700	28	Wm. Cramp & Sons.........	15.9	21.3
Number 18	700	28	Wm. Cramp & Sons.........	15.4	19.7
Number 19	700	28	New York Shipbuilding Co....	16.2	22.4
Number 20	700	28	Bath Iron Works............	9.7	11.5
Number 21....	700	28	Bath Iron Works...........	9.3	10.9
SUBMARINE TORPEDO BOATS.					
Cuttlefish.. ...	—	—	Fore River Shipbuilding Co...	99	99
Number 13 ...	—	—	Fore River Shipbuilding Co...	40.5	45.3
Number 14	—	—	Fore River Shipbuilding Co..	39.9	45.2
Number 15	—	—	Fore River Shipbuilding Co....	31.	44.9
Number 16 ..	—	—	Fore River Shipbuilding Co...	34.2	45.1
Number 17	—	—	Fore River Shipbuilding Co....	13.6	27.5
Number 18	—	—	Fore River Shipbuilding Co..	13.4	23.1
Number 19	—	—	Fore River Shipbuilding Co..	13	23.1

International Yacht Race in Honor of Columbus.

Spain intends to commemorate the 3d of August next, the anniversary of the departure from Palos of the ships *Santa Maria*, *La Pinta* and *La Nina*, by yacht races, which, starting from that port, will make the first stage of the voyage which was made by Columbus. The races will be from Palos, whence Columbus set sail, to the Canaries. The distance is 700 miles, requiring several days' navigation.

This year, by a happy coincidence, high water is at 6 o'clock in the morning on the 3d of August (this being the day and hour that, 415 years ago, the *Santa Maria*, *Pinta* and *Nina* set sail at high water), which will be taken advantage of this anniversary by the American-Spanish yachts to perform the first part of the journey Columbus made in 1492. The Mayor of Puerto Palos has arranged that the first sailing yacht to arrive shall anchor at the Palos quay, bearing east, and that those arriving later shall anchor up-stream, in the order of their arrival; so that on the 3d of August all the vessels which shall take part in the regatta shall pass over the exact spot from which Columbus' caravels sailed.

ENGINEERING SPECIALTIES.

Lubrication of Marine Engines.

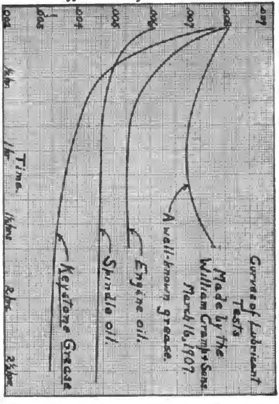
No other line of machinery demands more careful and scientific lubrication than that on board a modern steamship. Here troubles from overheated or scored bearings are scarcely excused under any circumstances, while at the same time there is demanded the highest degree of cleanliness, efficiency and economy. The lubrication of machinery is, in the first place, really a greasing proposition. It is grease that is needed between the surfaces of a journal and its bearings; and oil has never been anything else than a means for carrying the grease globules where they are needed. Why not, then, discard oil and use ordinary grease? Simply because ordinary grease contains substances which in time gum up the cup and bearing and cut the journal.

Keystone grease,* however, is said to be utterly and absolutely different from any other lubricating grease on the market. In the first place it is absolutely free from resin, resinuous oils, talc, asbestos, beeswax, soapstone or any other of the adulterants commonly used in other greases to give artificial body. It is a pure, clean petroleum product, containing nothing but grease globules in their most perfect form. It is a lubricating grease that needs no wasteful carrying agency, as is true of grease in oils, nor does it need help of any kind to enable it to maintain a greasing film, no matter what the temperature or pressure.

Being a purely mineral product this grease contains no stearine. Animal oils and greases always contain stearine; and when they are used for lubricating piston rods, valve stems, steam chests, or steam cylinders, a chemical action is inevitable, which produces stearic acid. This is very active, attacking iron readily, and even copper. A sample of Keystone grease analyzed by William Cramp & Sons' chemist was found to be entirely free from all deleterious substances, such as would cause decomposition of the grease or would have any detrimental effect upon metal surfaces.

A favorite method of applying greases is to place them in contact with the bearing, and depend upon the heat of friction to melt the grease and cause it to flow upon the bearing. In other words, the bearing must always be hot enough to melt the grease. Keystone grease does not change consistency under any variation of temperature up to 600 degrees F. This means that cold weather does not hinder its flow, nor does heat cause it to flow wastefully. It is made in eight different densities, ranging from a liquid suitable for fine high-speed service to a solid that will maintain a greasing film under the heaviest known pressures. These heavier grades are all applied by means of especially designed pressure cups,

Coefficient of Friction.



which are automatically or hand regulated as desired, and in either case the flow is uniform and certain. The fluid grades are applied very much as is ordinary heavy oil, but much less is required.

The lubricating efficiency of an oil or grease is indicated by the coefficient of friction obtained with its use upon a standard testing machine. The card shows the curves plotted from the tests of lubricants conducted by the Cramp Company. It will

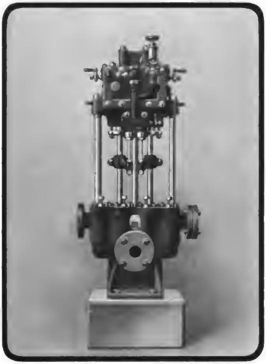
* Keystone Lubricating Company, Philadelphia, Pa.

be seen that the curve plotted from the results of the test on Keystone grease falls much lower than that of any of the other lubricants tested. The average coefficients of friction of the different lubricants were as follows: "Well-known" grease, 0.007; engine oil, 0.0053; spindle oil, 0.0047; Keystone grease, 0.0034.

Oddesse Pumps.

Of the many distinguishing features of this pump, produced by the Oddesse Pump Company, 47 Victoria street, London, S. W., the most striking is the great simplicity of the valve gear. The pump has none of the links, levers, rockshafts and external wearing parts of the ordinary duplex pumps, the valves being actuated by means of a very simple patented device consisting of an inclined slipper engaging in an inclined slot in a block partaking of the same motion as the piston rod. No setting of the valves is required; they can be taken out and examined without the possibility of not being properly replaced, and there are no nuts requiring accurate adjustment or that can get loose. As there are no external wearing parts whatever, the whole of the lubrication can be most effectively carried out by means of a lubricator on the steam pipe.

Another point of particular interest in the Oddesse pump is the means employed for bringing the piston to rest at the end of the stroke. In all ordinary duplex pumps the piston is allowed to pass over the exhaust ports, thus cushioning the exhaust steam. This method however, has the great drawback of being incapable of alteration for various speeds and



pressures. Hence the chief cause of short stroking at low speeds and knocking at high speeds. Again, when the pump is run at anything above moderate speeds, the compression of the exhaust steam at the end of the stroke causes a recoil of the reciprocating parts, which naturally results in a hammering action on the pump valves. In this pump the steam can be cut off at any point during the stroke, and the piston is brought quietly to rest by means of the fall of pressure in the cylinder, thus rendering a recoil of the reciprocating parts and short stroking impossible, no matter what speed and against what pressure the pump may be running.

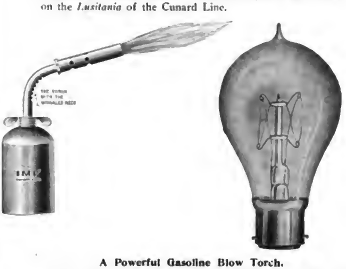
Owing to the simplicity of the valve motion, the expansion valves can be fitted very simply without the use of any levers, glands or joint pins, so that the Oddesse gear with cut-off valves remains far less complicated and more durable than the ordinary duplex gear without them. The point at which the steam is cut off is regulated by means of handles placed on either side of the valve chest, and in the larger sized pumps the expansion valves are automatically controlled by the slightest variations in the length of stroke made. These cut-off valves enable the pump to run at enormously high speeds without the slightest danger of any knocking of the piston or hammering of the pump valves, and it is this that makes this pump so serviceable on board ship as a ballast, bilge or fire pump.

Tantalum Lamps.

A new type of wire filament lamp has been placed on the market by Siemens Bros. Dynamo Works, Ltd., London, who are introducing a 25-volt tantalum lamp, for use with automatic transformers and on low voltage circuits generally. The lamps can be burned in any position.

The new lamp is for voltages of 24 or 25, and is supplied in 8 or 16 candlepower. Like all other types of tantalum lamps the filament is very strong; the 25-volt tantalum lamp may be used for train lighting and private house installations, especially in connection with small transformers. The bulb is smaller than that of the ordinary carbon filament lamp, but similar in shape.

These lamps have been supplied to all the ships of the Hamburg-American Line, and it is said that on the *Graf Waldersee* one dynamo is sufficient for the lighting, where three were previously used. Tantalum lamps are also in use on the *Lusitania* of the Cunard Line.



A Powerful Gasoline Blow Torch.

The "Imp" torch is a patented device which, it is said, will do as much work as most of the larger torches, with the advantage of compactness, simplicity and cheapness. It is entirely automatic in operation, has no pump or valve, needs no tools, starts with a match and gives a perfectly clean, powerful Bunsen flame for over two hours on four ounces of gasoline. The corrugated neck increases the heating surface to such an extent that the flame of a match easily generates gas enough for starting, after which the mixing tube renders further attention unnecessary.

The "Imp" is designed for electricians, automobilists, the handy man and anyone who wants intense, clean heat, cheaply

and quickly. It is made by the Frank Mossberg Company, Attleboro, Mass.

Magnalium.

An alloy consisting mainly of aluminum, but with a small percentage of magnesium, has been developed in Germany, and, on account of some rather remarkable qualities, has been put to various uses. It is being handled in the United States by Morris R. Machol, 32 Park Place, New York.

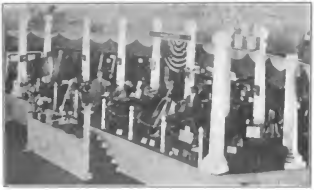
The alloy is very slightly lighter than aluminum, and may be used either cast, drawn or rolled. When cast in dry sand the tensile strength is said to be from 18,000 to 21,000 pounds per square inch, with a reduction in area of 3¾ percent. Cast in iron chills, the strength is about 4,000 pounds greater than in dry sand. A tensile strength of as much as 42,500 pounds is said to have been obtained by special treatment. Soft rolled sheets are accredited with a strength of 42,000 pounds and 15 percent reduction of area; hard rolled sheets with 52,000 pounds and 3 percent reduction of area. Wire drawn from this alloy is given 41,000 pounds and 10 percent reduction, while 53,000 pounds has been shown when the raw material was forged before drawing. When magnalium contains less than a certain percentage of aluminum it cannot be rolled, but can readily be drawn. In such case a bar has been shown to give 60,000 pounds per square inch tensile strength and a tube 74,000 pounds.

The metal is very close-grained, thus facilitating polishing. It can be turned at very high speed in a lathe, and will readily hold lacquer for polishing or etching. It is hard, but when annealed may be made so ductile that it can be rolled or beaten like silver. It is said to be practically impervious to the action of most acids and salt water, and as such to be peculiarly fitted for use in ship work and elsewhere, where it is necessary to resist corrosion.

Among the numerous articles which have been made of magnalium might be mentioned parts of delicate and other machinery; steam and water valves; optical instruments, and various parts of automobiles, bicycles and gasoline engines, such particularly as engine bases, etc.

Vanadium Steel.

Much interest was manifested in a recent exhibit by the Vanadium Sales Company, of Pittsburg, Pa., of vanadium products. The variety of the specimens was considerable, including open hearth and crucible steels treated with vanadium, vanadium cast iron, vanadium steel castings and vanadium copper and bronze, of considerable hardness, strength and ductility.

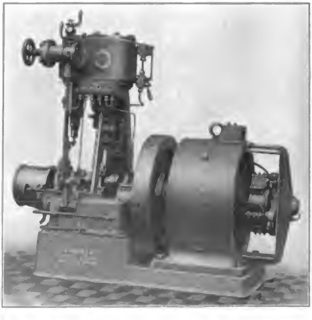


In drop forgings, vanadium steel flows quite readily in the die, its heat treatment being very simple. No more trouble is experienced in machining it than is met with in the ordinary steel with an equal proportion of carbon. The forgings take a high finish. Its peculiar quality to resist deterioration, arising from vibration, strain and fatigue, is exemplified in the service of a large number of vanadium steel springs now in use. A locomotive tender truck spring exhibited had been straightened 10,000 times under much greater force than would have been necessary to flatten any other type of spring, and this without any permanent set. Among the other exhibits was a wheel taken from under a locomotive tender weighing 140,000 pounds, this wheel having run 26,875 miles and showing a wear of but 1/16 inch in diameter. The average life of the regular steel wheel is only a little more than 10,000 miles.

A six-throw crank shaft for an automobile was another item. Still another exhibit was part of a torpedo, recently tested with gratifying results. Where great strength, toughness and power of resisting shock are desired, this material seems to have a large future before it.

A Multipolar Generator Set.

The Castle type dynamo set is made by J. H. Holmes & Company, Newcastle-on-Tyne, the dynamo being coupled direct to a vertical engine, both on the one bedplate, and especially designed for use on shipboard. The engine is of the slow-speed type, all wearing parts having large surfaces and being supplied with efficient lubrication, so that continuous running involves no risk of heated bearings. The moving parts are so balanced as to run without vibration or excessive wear.



Steam pressures up to 170 pounds are used. In many cases a simple engine is fitted but in some cases compound engines are substituted, running at the same speed, but necessarily more expensive per installation.

The type illustrated is built in a large variety of sizes, ranging from 1.1 to 18.5 kilowatts. The range in speed is from 450 to 300 revolutions per minute, all being designed for 100 volts. The smallest in the regular list has a cylinder 4 inches in diameter by 3 inches stroke, and measures complete 4 feet 2 inches in length, 18 inches in width and 3 feet 4 inches in height. The largest engine listed has a 9-inch cylinder with 7-inch stroke, and measures complete 6 feet 8 inches in length, 2 feet 10 inches in width and 5 feet 9 inches in height.

TECHNICAL PUBLICATIONS.

Lloyd's Register of American Yachts. Size, 9 by 7 inches. Pages, 454. Colored plates (flags), 45. New York, 1908: Lloyd's Register of Shipping. Price, $7.50 (30/-).

The sixth annual volume shows a material increase in size over last year, and has been thoroughly revised in all particulars, especially in those relating to the engines of the rapidly-growing fleet of cruising launches. There are listed a total of 3,670 yachts, both sail and power, owned in the United States, Canada and the West Indies, with a total of some 3,500 yacht owners. The color plates give 2,013 private signals of American yachtsmen, and the burgees of 365 yacht clubs.

One of the most interesting features of the book, as showing the growth of American yachting, is the list of the yacht clubs. The first American Yacht List published in 1874 by the late Neils Olsen, listed a total of thirty-two yacht clubs, and the greatest number listed prior to the establishment of Lloyd's Register of American Yachts was about 170. Lloyd's club list has grown steadily since 1903, until it has now reached a total of 386 clubs distributed in all parts of the United States and British North America. Not a few of these clubs have been established during the past winter.

This great increase is made up in three ways: first, of yacht clubs established in new localities; second, of new clubs established to meet the recent growth of the sport in localities where many clubs already exist. The third class of clubs, a large one and distributed in all parts of the country, is made up of the so-called "power boat," "motor boat" and "launch" clubs, organized by men who have no special interest in the older forms of yachting, but are enthusiasts in the cause of the modern power boat.

British Engineering Standards Coded Lists. Vol. V. Size, 8½ by 11 inches. Pages 411 + xxxix. Structural Steel for Shipbuilding and Marine Boilers Steel Castings and Forgings for Marine Purposes. Marine Code compiled by James Adamson. London, 1908: Robert Atkinson. Price, 25s. net.

The British Standard Marine Code is designed for the use of shipowners, ships' officers, shipbuilders, marine engineers and all those handling marine material, whether afloat or ashore. The latest details in all the various matters coming within the scope of modern marine engineering are carefully and systematically dealt with; and as the compiler has had a long experience of requirements for ships under various circumstances, he has incorporated the results in a most convenient form for ready reference by every one whose duty or interest lies in the, direction of shipping and ships, sea or river navigation.

The code is divided into sections, and the index itself is a useful compilation for general service by all those whose business is connected with water-borne traffic. The ship is dealt with in a great many varied circumstances of location, of suitability for cargoes, of damage and repairs, under conditions derived from experience, including dry-docking and surveying necessities or requirements. The machinery in all details of latest equipment of turbine, watertube boilers, forced draft, hydraulic, electrical, refrigerating, steering gear and deck machinery are treated fully for repairs in all cases where found necessary.

In addition to the propelling machinery, all other machines, such as evaporators, feed-water filters and feed-water heaters, are also treated fully, with phrases for reporting condition of machinery, details, repairs, or renewals required; also ordering phrases for material connected with boilers and machinery, whether propelling or auxiliary. The propeller is dealt with under every circumstance; and with the assistance of a convenient sketch, a shaft can be ordered by telegram in full detail, or dimensions confirmed. The turbine has a section to itself, and is given in minute particulars for all classes of repairs. The diagram for the location of turbine units, together with the phrases, will be found most useful.

Besides the marine code, this volume contains coded list of the British standard sections, and specifications for structural steel for shipbuilding, for marine boilers, ingot steel forging and steel castings for marine purposes. The great value of a good index in saving time and temper is well known; this has evidently been kept in view by the compiler of the code.

Autogenous Welding of Metals. By L. L. Bernier, M. E. Size, 4½ by 6½ inches. Pages, 45; illustrations, 22. *The Boiler Maker*, New York, 1908. Price, $1.00 (4/-).

This work gives a detailed description of the various means employed for obtaining high temperatures for the welding of metals. The most common forms of apparatus are thoroughly described, and an account is given of how this process has been applied commercially. The book gives a comparison as to cost, suitability for various kinds of work and ease of handling of the various types of blow-pipe burners in use. The three important burners described are the oxyhydric burner, using oxygen and hydrogen; the oxyacetylene burner, using oxygen and acetylene, and the oxygas burner, using oxygen and illuminating gas. Comparison is made in the case of portable welding apparatus between blow-pipes using dissolved acetylene and oxygen and hydrogen and, in the case of stationary welding apparatus, between oxyacetylene blow-pipes, using acetylene supplied by a generator, and the oxygas blow-pipe. In both cases the subject is thoroughly discussed from the point of view of the comparative cost prices of the two systems and from the point of view of easiness in handling and application. Charts are given on which curves have been plotted showing the total cost per unit distance to weld various thicknesses of metal by each of these systems. The curves show the total cost, including gas and workmanship, and also the cost in gas alone.

The Log of the Blue Dragon. By C. C. Lynam, M. A. Size, 6½ by 9¾ inches. Many illustrations, including maps. Oxford, 1908: Slatter & Rose. Price, 6/- net ($1.50 net).

The marine engineer has to take into consideration a large number of conditions not immediately concerned with the question of machinery, and in consequence has a closer interest in the sailing ship than would appear at first sight. For this reason we make no apology for referring briefly to a new (second) edition of this work, which is a record of numerous cruises in a small boat the skipper of which is a well-known amateur sailor. His cruises range from Oxford on the River Thames, around the south coast of England and to the north of Scotland. Dangerous and difficult navigation is entailed in such a trip, and the logs are a record of great interest to anyone interested even remotely in the sea and in things marine. Those marine engineers, and they are many, who themselves regard sailing as a useful hobby, because it brings them into close touch with the conditions in which their inventions are tested, will find the book full of fascinating interest.

The Naval Pocketbook for 1908. Edited by G. S. L. Clowes. Size, 3½ by 5 inches. Pages, 991. Numerous illustrations. London, 1908: W. Thacker & Company, 2 Creed Lane, E. C. Price, 7/6 net ($2.00).

This is the thirteenth year of a series of annual volumes dealing with the navies of the world, and giving much detailed information regarding the individual ships of which those navies are composed. These details include the usual dimensions, power, speed, battery and armor, and a considerable amount of miscellaneous items. There are also lists of the different types of guns used in various naval services, a complete table of the drydocks of the world and other subsidiary

tables. The last section includes outline sketches, showing battery and armor distribution of the principal ships of the various powers.

The work is decidedly conservative, in so far as information and illustrations are concerned, of the very latest ships laid down by Great Britain, Germany and Japan. It is true that extraordinary efforts are being made by these powers to keep the details from becoming public; at the same time much is known and much more is very closely surmised, so that sketches have been made representing probably the correct arrangement of the battery, and, to a certain extent, of the armor. This conservatism has led to the omission of sketches of such well-known ships as the British *Indomitable* class and the American *Delaware* class, in both of which the battery arrangements are thoroughly well known, and the armor also. In spite of these failings, however, the work is a very valuable compilation, and enjoys a deserved popularity. The number of ship illustrations is 127, representing probably upwards of 400 ships, because of the fact that very many illustrations cover several sister ships.

QUERIES AND ANSWERS.

Questions concerning marine engineering will be answered by the Editor in this column. Each communication must bear the name and address of the writer.

Q. 411.—Give a rule for figuring the pressure to be placed on a spring-loaded safety valve.

2.—What is the coal consumption of the *Lusitania* or *Mauretania* per voyage, per horsepower, etc.? J. S.

A.—The load to be placed on a spring-loaded safety valve would be equal in pounds to the area in square inches of the inside of the valve in communication with the steam inside the boiler, multiplied by the pressure in pounds per square inch at which it is desired to blow off. If the area of the valve is 6 square inches, and it is desired to blow off at 200 pounds per square inch, the spring should be so adjusted as to create a thrust against the valve seat of 1 200 pounds.

2. Regarding the coal consumption of the *Lusitania*, a paper read before the Institution of Naval Architects in April is reprinted on another page in this number, and gives the information desired.

Q. 412.—Regarding Lightship Number 88, at page 375, in your September, 1907, number, you give the beam as 29 feet; at page 197 in May, 1908, you give it as 27 feet. Which is correct? A. B. B.

A.—We are informed by the Lighthouse Board that the molded beam of this vessel is 29 feet.

Q. 413.—Please differentiate between the Clyde boiler and the Scotch boiler. G. W. T.

A.—The Scotch boiler is one having one or more internal flues or furnaces, with return tubes around and above these flues for the passage of the products of combustion to the up-take and funnel. The front end of the furnace is located at the front of the boiler. The rear end of the furnace opens into a combustion chamber, which connects the furnace with the tubes. The tubes, furnace and combustion chamber are entirely surrounded by water (except, of course, in the front end, where the furnace is arranged for firing and the tubes for discharging the products of combustion up the stack), this water being contained within the cylindrical shell of the boiler. This boiler is also known as the cylindrical marine boiler, and sometimes as the return tubular boiler.

The Clyde boiler is of the same general type, except that the combustion chamber is not surrounded by water. For this reason it is often called a "dry-back Scotch boiler." It is not used to any extent in marine service, and has in general only one furnace, where the Scotch boiler frequently has four.

The Scotch boiler is often made double-ended, each end being a duplicate of the other, and having usually either three or four furnaces in each end. In such case the combustion chambers for the two ends are sometimes merged into one common chamber, but more often two chambers are used, separated by a water space with a thickness of 4 or 5 inches.

OBITUARY.

John B. Roach, president of the Delaware River Iron Shipbuilding & Engine Works, Chester, Pa., died suddenly June 16, at the age of 68. This yard attained prominence 25 years ago by constructing the first four steel vessels (the A, B, C and D) of the "new" United States navy—the *Atlanta, Boston, Chicago* and *Dolphin*. Among the later products of the yard are the two turbine steamers *Yale* and *Harvard*. The yard, under the management of Mr. Roach, and, previously, of his father, John Roach, attained an enviable reputation for careful and thorough workmanship.

SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

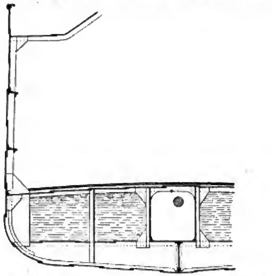
American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

884,474. RECIPROCATING PROPELLER. WILLIAM DAWSON, HAWARDEN, IOWA.

Claim 2.—A propeller comprising a plurality of tubular outer casings, having formed in their upper and lower sides longitudinally disposed guide channels, tubular inner casings adapted to fit and slide in said outer casings, guide studs arranged on the inner casings to engage the guide channels in said outer casings, whereby the inner casings are guided and steadied in their movement in said outer casings, means to reciprocate the inner casings, pivot shafts arranged therein, wings or blades pivotally mounted on said shafts and adapted to swing inwardly and outwardly to open and close the inner casings when same are reciprocated, and means to prevent said wings from folding entirely together when swung inwardly to open said casings. Three claims.

884,912. CONSTRUCTION OF SCREW-PROPELLED SHIPS. JOHN T. DUNCAN, CARDIFF.

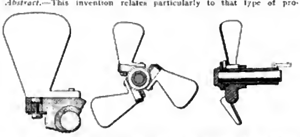
Claim 1.—In a screw-propelled ship, a shaft tunnel, a roof to said tunnel extending to the sides of the ship, and permanent water



ballast tanks on each side of said tunnel, located beneath the extended roof thereof. Five claims.

885,058. PROPELLER. ALBERT GNAEGY, CHESTER, ILL.

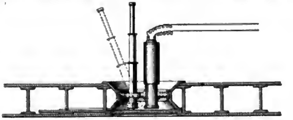
Abstract.—This invention relates particularly to that type of pro-



pellers having shiftable or reversible blades to facilitate the movement of a vessel in opposite directions. One claim.

885,087. SUBMARINE VIEWING APPARATUS. MANSOUR SAMAHA, WASHINGTON, D. C.

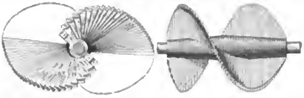
Claim 1.—The combination with a hull, of a submarine viewing apparatus comprising a single search light, and a plurality of fixed



optical tubes arranged at different distances from the axis of the search light, each having its axis arranged to intercept the axis of the search light at a predetermined distance from the hull. Fourteen claims.

885,109. SCREW PROPELLER. THOMAS F. J. TRUSS, LONDON.

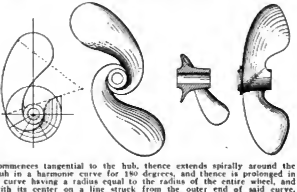
Claim 1.—In a screw propeller, the combination of an elongated boss tapered at the ends, and screw blades thereon of such a length



that there is no complete interval between the turns in end view, such boss and blades comprising a series of laminæ each having arms, and central shaft-receiving boss portions secured together in such relation to one another as to form helicoidal blades, each lamina being tapered from the tip toward the boss. Six claims.

885,174. PROPELLER WHEEL. HARRY J. PERKINS, GRAND RAPIDS, MICH., ASSIGNOR OF ONE-THIRD TO FREDERICK L. PERKINS, AND ONE-THIRD TO CHARLES E. PERKINS, GRAND RAPIDS.

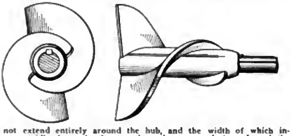
Claim 2.—A propeller wheel comprising a hub and a blade whose forward edge, when projected on a plane perpendicular to the axis,



commences tangential to the hub, thence extends spirally around the hub in a harmonic curve for 180 degrees, and thence is prolonged in a curve having a radius equal to the radius of the entire wheel, and with its center on a line struck from the outer end of said curve, and perpendicular to a line tangential to said curve at its outer end, said edge being curved rearward in substantially a cycloidal curve when projected on a plane parallel to the axis. Four claims.

885,250. PROPELLER. GEORGE W. HOPKINS, BROOKLYN, NEW YORK.

Claim.—A propeller comprising a central hub which is cylindrical in form in cross section, and provided with two spiral blades which



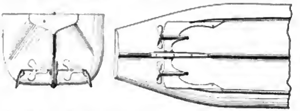
do not extend entirely around the hub, and the width of which increases rapidly from the front end to the rear end thereof, and the radial width of which is greatest at the rear end, where they terminate in straight lines which are oblique to the axis of the hub, and approximately tangential to the periphery thereof. One claim.

885,312. STEERING GEAR FOR BOATS. EARL C. AKERS, PORT HURON, MICH.

Claim 1.—A steering gear for boats comprising, in combination with the rudder and a rudder-actuating mechanism located abaft amidships and provided with a controlling device, a steering wheel located at the forward part of the boat, and a rigid inextensible connection between said wheel and the controlling device of the rudder-actuating mechanism, arranged to operate the latter in both directions of movement of said connection, said connection serving to promptly transmit to the rudder the steering movements of the wheel, and operating to maintain the relation of the steering wheel to the rudder. Twenty-two claims.

885,370. HULL OF VESSELS. ISAAC E. PALMER, MIDDLETOWN, CONN.

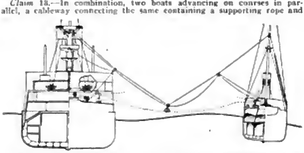
Claim 3.—The combination with the hull of a vessel provided with



a shaft bearing and bilge keels, of fins projecting in opposite directions from the shaft bearing, and forming an extension of the bilge keels. Three claims.

885,774. CONVEYING APPARATUS. THOMAS S. MILLER, SOUTH ORANGE, N. J.

Claim 18.—In combination, two boats advancing on courses in parallel, a cableway connecting the same containing a supporting rope and



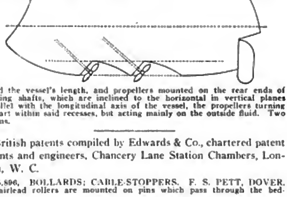
a load carriage traction rope, a take-up and pay-out mechanism on one of said boats exerting tension on said supporting rope, and a take-up and pay-out mechanism on the other of said boats exerting tension on said traction rope. Twenty-seven claims.

886,621. TRANSPORT VESSEL. OTTO MEHRTENS, KIEL, GERMANY, ASSIGNOR TO FRIED. KRUPP AKTIENGESELLSCHAFT GERMANIAWERFT, KIEL-GAARDEN.

Claim 1.—A transport vessel having a double hull extending throughout the bottom and up to the harbor deck, and a sea-proof superstructure surmounting the harbor deck, and having side walls extending directly from the inner wall of the hull and inclined to the horizontal at an angle approximately corresponding to the rake or slope of the cargo. Two claims.

886,850. PROPULSION OF VESSELS. GIOVANNI PERTOT, MILAN, ITALY.

Claim 2.—A navigable vessel having recesses in the bottom thereof on opposite sides of the keel at a distance from the bow equal to about one-



third the vessel's length, and propellers mounted on the rear ends of driving shafts, which are inclined to the horizontal in vertical planes parallel with the longitudinal axis of the vessel, the propellers turning in part within said recesses, but acting mainly on the outside fluid. Two claims.

British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

25,806. BOLLARDS; CABLE-STOPPERS. F. S. PETT, DOVER.

Fairlead rollers are mounted on pins which pass through the bed-

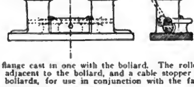


plate and a flange cast in one with the bollard. The rollers may be in any position adjacent to the bollard, and a cable stopper may be fitted between the bollards, for use in conjunction with the fairlead rollers.

26,132.—SEA-SOUNDING APPARATUS. W. THOMSON, KELVIN, BARON, F. W. CLARK, AND KELVIN & JAMES WHITE, GLASGOW.

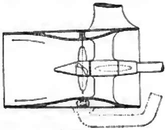
The machine is modified by mounting a motor below the reel to drive it through bevel-gearing for winding-in. A smooth-surfaced wheel facilitates handling when the wire is being rapidly wound in.

25,628. SALVAGING SHIPS. A. BECCHI, AND G. B. TARANTINI, GENOA, ITALY.

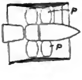
A self-propelled apparatus for burrowing underneath a sunken ship, carrying a rope with it, consists of s casing provided externally with two propellers or screw augers on shafts which are set at an angle to one another. The propellers are driven by a motor, which also actuates a pump used to empty the ballast tank. When the apparatus has reached the bottom of the ship, the intake valve is closed, and the ballast tank begins to empty.

27,133. SCREW PROPELLERS. V. WADAGAKI, NODEO, KINOSAKI, JAPAN.

A fixed or hinged tube is situated around the screw propeller and is flared at its forward and after ends, the cross-sectional area decreasing from each end towards the mid-length or a point situated a little forward of the mid-length of the tube. The screw propeller is situated at the most contracted portion of the tube, so that it may operate in water having a relative velocity much higher than the forward speed of the vessel. The outlet area is slightly less than the inlet area. The tube may be in two parts, covered with plating, fitting flush with the outer surface, and it may be pivoted so that it may be turned to steer the vessel.



27,133.



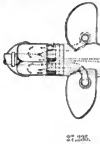
27,181.

27,181. SCREW PROPELLERS. A. RIGG, LONDON.

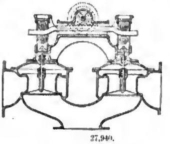
A screw propeller is mounted within a casing or tunnel which is fitted astern of the propeller, with fixed or adjustable guide blades, P. The casing is constructed with a bell-mouth forward, or forward and aft, the narrowest portion being situated between the propeller and the guide blades. The exterior of the casing is provided with a suitable filling, in order to present a smooth outer surface.

27,235. SCREW PROPELLERS; PROPELLING BY WATER-JETS. W. LOVIS, AND A. RANKIN, LONDON, E.

The blades of screw propellers are provided with perforations to which are attached tubes leading to the boss. Connected with the tubes are tubes telescoping in the casing, which is slidable on the shaft. Rotation of the propeller forces water through the tubes into the casing, from which it discharges, through pipes, to the after end of the propeller boss, to assist in propulsion.



27,235.



27,940.

27,940. ELASTIC FLUID TURBINES. E. BROWN, OF BROWN, BOVERI & COMPANY, BADEN, SWITZERLAND.

Relates to controlling valves for marine turbines which control the engines from a single point, and comprises means whereby some valves are positively held in the closed position while others are opened. The valves are actuated by a rack-driven cam-bar, which bears against rollers. In another form, the valves are operated by a worm-driven cam, which acts on pivoted levers. In both forms, a spring connection is provided between the valve and the spindle, to take up any slack.

27,409. ELASTIC FLUID TURBINES. R. PAWLIKOWSKI, GORLITZ, GERMANY.

The loss of steam through the clearance spaces of a steam turbine is prevented by causing the steam to impinge upon guide and moving vanes which are not parallel, so that the steam passes along cylindrical surfaces concentric with the drum. In one form, this is accomplished by arranging straight vanes obliquely to the radii; in another form, the vanes are bent longitudinally so as to form involutes to the drum. A further method, applied to involute vanes having a portion bent backward, consists in twisting the vanes so that their axes lie obliquely to the generatrix of the cylinder. The invention may be applied to either the guide or moving vanes, or to both.

27,565. SHIPS. PROPELLING BY RECIPROCATING PLATES. J. CRAVEN, THORNTON, YORKSHIRE.

A number of plates are housed in recesses in the side of a ship,

and are connected to shafts, linked by arms to rollers, the shafts and rollers working in two guides. The first guide is a straight slot, and the shaft which slides in it is connected to the piston of the engine. The roller moves along the curved guide in such a manner that the plate is vertical during one stroke, and horizontal during the return stroke. A modification is described in which the roller is replaced by a toothed wheel engaging a rack on the guide.

27,917. SHIPS' STEERING GEAR. VICKERS, SONS & MAXIM, BARROW, AND A. T. DAWSON, WESTMINSTER, LONDON.

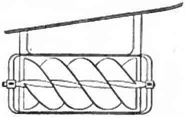
Arrangements are made to bring electric or other motive power automatically into action for augmenting or replacing the manual operation of the apparatus. The steering wheel is mounted on a shaft, which passes loosely through a sleeve having upon it a worm in gear with a pinion, loosely mounted on the vertical shaft. The pinion drives the bevel gears and rotates the vertical shaft, connected by bevel wheels to the horizontal shaft, by which the steering gear is operated.

28,367. SHIPS' CABINS. N. CHAMBERLAIN, J. STOKES AND HOSKINS & SON, NEPTUNE WORKS, BIRMINGHAM.

Portable rooms or cabins are constructed of sectional bulkheads or partitions, retained in position by cross-rails or their equivalent, detachably secured to stanchions fitted between the decks. The side of the cabin in which the door is situated is constructed of three sections. The edges of the central section, containing the door, are convex in form and fit into the concave edges of the other two sections. The remainder of the sections which form the cabin are similar to the latter two sections, so that they may be interchangeable. The pieces of each section are stiffened by bars of trough or channel section, and by the socket bars which carry the berths.

28,437. SCREW PROPELLERS. J. R. PORTER, MIDDLESEX.

One or more cylinders, which are wholly immersed, are fixed to the vessel by struts, and carry within them shafts upon which are



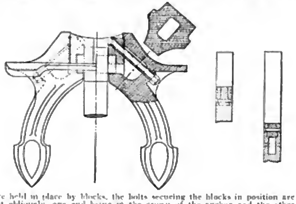
helical blades. The length of one convolution of the blades is the same as the length of the inclosing cylinder. The blades may be bent over so that their outer edges are tangential to the cylinder, and the extremities of the blades may be connected at intervals by hoops.

28,447. SHIPS' TANKS. I. P. B. KNUDSEN, COPENHAGEN, DENMARK.

In ships provided with top water-ballast tanks arranged along the sides, warm water from the condenser is pumped through these tanks, instead of steam, to prevent the water in them from freezing.

29,063. ANCHORS. G. HEPBURN, LIVERPOOL, AND J. E. FLETCHER, DUDLEY, WORCESTERSHIRE.

In stockless anchors of the type in which the shank is provided with trunnions, which fit in sockets in a cavity in the head, and



are held in place by blocks, the bolts securing the blocks in position are set obliquely, one end being in the crown of the anchor and the other between the trippers and the flukes. To insure good and sound castings, a cavity is cored out, and the metal of the crown is carried to the trippers in a plain flush surface. Two webs are provided when the flukes meet the head of the anchor, forming cavities which contain the nuts of the bolts.

29,407. ELASTIC FLUID TURBINES. MASCHINENFABRIK OERLIKON, ZURICH, SWITZERLAND.

Turbine blades are axially riveted in undercut grooves formed on the periphery of the rotor. The bottom of the undercut grooves may be provided with a second annular groove, into which the roots of the vanes or distance pieces may or may not extend.

29,142. PROPELLER SHAFTS. R. THOMPSON, WEST HARTLEPOOL.

The tail shaft is enlarged at the parts that adjoin the brass liners, and are most liable to corrosion, instead of being of uniform diameter

throughout. Collars are forged on the shaft, and the recessed surfaces between them accommodate brass liners, which are cast in place. The thinned-off edges near the collar insure a minimum of electric action, and consequently of corrosion.

International Marine Engineering

SEPTEMBER, 1908.

THE LAKE PASSENGER STEAMER CITY OF CLEVELAND.

The Detroit & Cleveland Navigation Company's new steamer, *City of Cleveland*, designed by Frank E. Kirby, naval architect, Detroit, and built by the Detroit Shipbuilding Company, is of the following dimensions:

Net tonnage	2 403; gross, 4,568
Length over all	404 feet.
Length on keel	390 feet.
Beam, hull	54 feet.
Beam over guards	92 feet 6 inches.
Depth	22 feet.

A CORNER OF THE CONVENTION HALL OR SMOKING ROOM ON THE CITY OF CLEVELAND.

(Six Photographs, Copyright, Detroit Publishing Company.)

The hull is constructed of mild steel, divided into ten compartments by watertight cross bulkheads. A double bottom is fitted, extending nearly the entire length and divided into compartments, which provides for the safety of the ship in event of grounding, and can be used to vary the trim and the draft by means of water ballast. Powerful pumps are fitted for this purpose. A steadying tank of 100 tons capacity is provided, to check the rolling in a heavy sea.

The shell plating includes a keel 36 inches by 30 pounds amidships, and nine strakes amidships on each side. Of the latter the garboard strake (*A*) and strake *I* measure 22½ pounds amidships and 16 pounds at the ends. Strakes *B*, *C* and *D* measure 21 and 16 pounds amidships and at the ends. Strake *E* is 25 and 16 pounds; *H* is 27½ and 16 pounds; *K* is 25 and 13 pounds; and *S* is 25 and 13 pounds, with a 25-pound doubling plate in way of shaft. The tank top plates measure 13 pounds in machinery space and 11 pounds forward and aft, with margin plates of 16 and 13 pounds respectively. The vertical center line keelson is 42 inches by 18 pounds. The frames above the double bottom consist of 6 by 3½-inch by 15-pound channels, with occasional web frames of 16 pound plate, fitted with double 5 by 3-inch by 9.8-pound angles at the inner edge. Between the double bottom and the main stringer plate are two fore-and-aft stringers, consisting in each case of a 6¼ by 3⅝-inch by 21-pound Z-bar, backed up by an angle 3 by 3 inches by 7.2 pounds. The main stringer measures 45 pounds, decreased to 13 pounds at the ends, and is provided with a 30-pound doubling plate at the shaft.

The main deck beams are channels, 12 inches by 30 pounds for one-half length, decreased successively to 25 and 20½

THE CITY OF CLEVELAND RUNNING AT FULL SPEED ON LAKE ERIE.

pounds. They are spaced 5 feet between centers. These beams are continued out under the guards by 6⅛ by 3⅝-inch by 21-pound Z-bars 5 feet apart, the latter being supported, as shown on midship section, by a cantilever frame work, the lower member of which is a T-bar, 4 by 4 inches by 13.7 pounds, while the other members are angles, 3 by 3 inches by 7.2 pounds. The promenade deck is supported by a frame of transverse I-bars, 15 feet apart and measuring 7 inches by 20 pounds, upon which are mounted, on each side of the center, five longitudinal I-bars of the same size, carried upon 13-pound rider plates. These longitudinals carry wooden deck beams measuring 4⅞ by 2⅞ inches, and spaced two feet between centers, upon which is laid the flooring. One photograph shows very clearly this arrangement. The deck beams above this are of wood, as indicated on the drawing of the midship section, page 378.

As shown in the longitudinal section, a very heavy framework is built up as a support for the paddle wheel shaft and to take the thrust of the engine. The plates are 16 pounds per square foot. Running fore and aft in the boiler room are auxiliary longitudinals, consisting of 15-inch channels, to compensate for the cutting of beams by the up-takes and funnels. The engine bedplate measures 25 feet 2 inches athwartship at the crank end, and 7 feet forward and aft on the inclined line. The cylinder foundation is upon a separate portion of the structure further aft.

The ship has seven decks; the main deck is of steel, sheathed with wood, to deaden the noise of handling cargo, for which the main portion forward of the machinery is used. The passenger entrance is located aft of the machinery, and forms a large lobby fitted with wide stairs extending to the upper decks, on which are located the staterooms, parlors and public rooms. Additional access is provided to all decks by a passenger elevator, with entrance off the lobby.

As shown in the longitudinal section, the central part of the orlop deck and hold is occupied by machinery. The forward end of the hold contains the dynamo room, fresh water tanks and space for stores; the after end contains the steering

BAGGAGE SPACE ON MAIN DECK. OVERHEAD IS SHOWN THE UNIQUE SYSTEM OF DECK BEAMS.

and ventilating engines, galley stores, fresh water tank and refrigerator. The entire forward end of the orlop deck is arranged for the crew, space being here provided for eighteen seamen, nine firemen, nine coal passers, thirteen in the engine room force, twelve galley men, thirty-five waiters, fifteen porters and twenty-four miscellaneous, making a total of one hundred and thirty-five. The after end of this deck is occupied by the galley, stretching from side to side of the ship; the pantries; the main dining room, which contains twelve round tables seating six each; two private dining rooms, seating respectively six and fourteen; and the buffet lunch room. These are constructed entirely of steel and made fireproof.

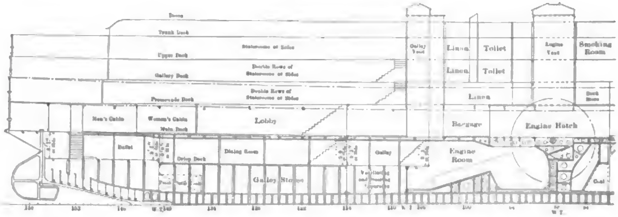
THE GALLERY AFT, SHOWING STAIRS LEADING UP FROM LOBBY ON MAIN DECK.—A PARLOR SUITE.

The main deck extends the full width of the ship over the guards. Nearly the entire portion is open for the stowage of baggage and freight. At the forward end is the windlass room for handling anchors, while provision is here made for carrying a few horses. Along the sides of the freight space are the paddle boxes, mess rooms and toilet rooms for various members of the crew. The after end is taken up with baggage rooms, the grand entrance lobby and two cabins. This deck includes quarters for seventeen of the crew, including the chief engineer and the purser.

The promenade and gallery decks are given up almost entirely to passenger accommodation. Down the center line are engine and boiler casings and ventilators, as well as staircases. On each side of the center line are three rows of staterooms. The two outer rows are arranged as "tandem" rooms, each having air and light from outside. The inner row obtains air by means of special ducts. The upper deck has a broad promenade space on the outside of the deck house,

and, as a result, there is space for only a single row of staterooms. At the forward end of this deck are quarters for the navigating department, including the captain and ten others. Six musicians and the wireless telegraph operator (Clark's system) are also accommodated on this deck.

Aside from the cabins on the main deck, and the broad hallways and gallery, the only public gathering room is on the upper deck, surrounding the after funnel. This is known as the "Convention Hall," but is more properly the smoking room. It measures 51 feet in length by 23 feet in breadth, and is tastefully upholstered in leather. Among the 342 staterooms are twenty cabins de luxe, or "parlors," each with a private bath. Eight of these baths are tubs, while the other twelve are showers. These parlors, which are located on the promenade and gallery decks, are very daintily decorated. Six of them are provided with private balconies at the ship's side. The whole scheme of decoration throughout the vessel appears to tend towards simplicity. Beautiful examples of Circassian walnut quartering are seen in a number of the apartments; while the gallery is paneled in mahogany, with the style of Louis XVI. The decorative work was designed by Louis O. Keil, Detroit. The decorative ceiling and panel paintings are due to William de L. Dodge, New York. Above the main staircase in one of our illustrations will be seen a frog, the "patron saint" of the line. Since the photograph was taken, the ship's clock has been added to this frog, which greets everyone going up the main staircase from the entrance lobby.

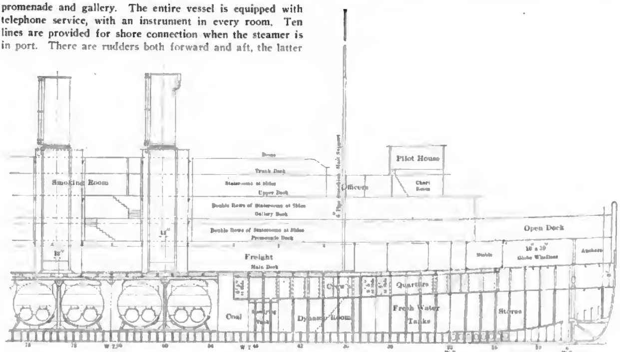


AFTER END—LONGITUDINAL SECTION—THE LAKE PASSENGER STEAMER CITY OF CLEVELAND.

The boat equipment consists of twelve lifeboats carried on the upper deck, eight being 24 feet long, two 20 feet and two 18 feet. The gallery extends through from this deck to the promenade deck, and by means of the main staircase aft, to the lobby on the main deck. An elevator runs from the orlop deck to the upper, passing successively through the main,

THE CRANK END OF THE MAIN ENGINE.

promenade and gallery. The entire vessel is equipped with telephone service, with an instrument in every room. Ten lines are provided for shore connection when the steamer is in port. There are rudders both forward and aft, the latter



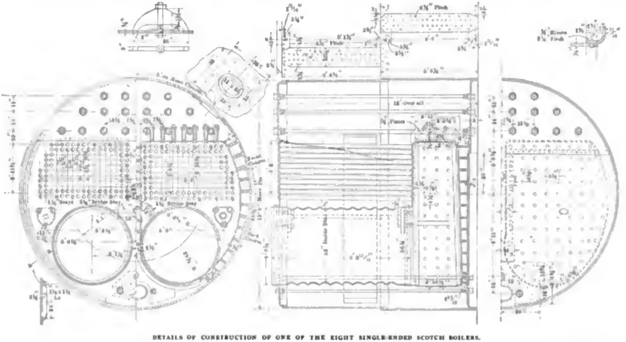
THE LAKE PASSENGER STEAMER CITY OF CLEVELAND—LONGITUDINAL SECTION—FORWARD END.

being balanced. The forward rudder is fitted to facilitate maneuvering in narrow waters. In addition to the usual steam steering engine fitted to both rudders, there is fitted Akers's auxiliary steam steerer to the stern rudder. This is arranged to be quickly connected from the pilot house, actual operation requiring about ten seconds.

For protection against fire, in addition to the usual equipment required by the United States steamboat laws, a complete sprinkler system is installed, together with a thermostat automatic alarm system in every room, which will give alarm in event of fire breaking out. All of the staterooms and crew's sleeping rooms are provided with fixed washstands, supplied with running water. The ship is ventilated throughout with cool, fresh air by the McCreery system. She is fitted with the Nicholson ship log.

A complete electric lighting plant is provided of 2,200 lights capacity, including a search light of 5,000 candlepower; and consists of three 30-kilowatt Western Electric Company generators, each driven by a Fuller single-acting Cornish cycle double-cylinder engine.

The propelling machinery, driving feathering paddle wheels, consists of an inclined three-cylinder compound engine; diameter of cylinders, high-pressure, 54 inches; two low-pressures, 82 inches each; stroke of pistons, 8 feet. The high-pressure



DETAILS OF CONSTRUCTION OF ONE OF THE EIGHT SINGLE-ENDED SCOTCH BOILERS.

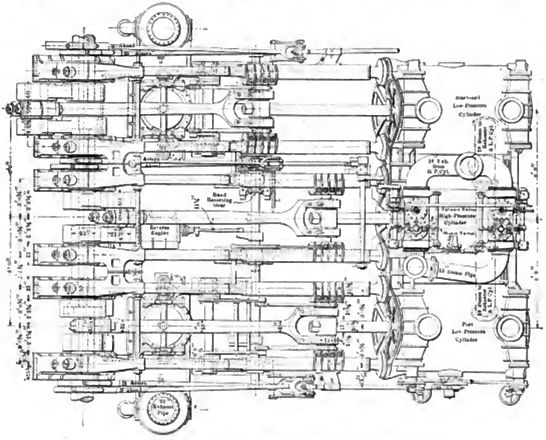
engine is fitted with poppet valves and the Sickels cut-off gear; the low-pressure cylinders are fitted with Corliss valve gear. The main crank and paddle shafts are of steel, forged hollow, and rigidly coupled together in line across the ship. The crank pins are of steel, forged hollow. The paddle wheels are 29 inches in diameter, each having eleven paddles, 14 feet long by 4 feet 6 inches wide.

This type of engine was used because it was necessary that a type should be selected which would work with equal efficiency at high and low powers. This steamer is intended to make two trips a day, the day trip, in which time will be at a premium, to be at high speed, and the night trip conforming to the present schedule. It was also desirable that one-third of the total power should be developed in each cylinder, instead of having, as is usual in three-cylinder compound engines, the high-pressure cylinder developing almost

and 4 feet 2½ inches long over all. The cross-head pins are 13 inches in diameter and 38 inches long over all, with two bearings, each 10½ inches long. The reverse shaft has a diameter of 8 inches. The reversing engine is 20 by 30 inches, and is supplemented by hand reversing gear. The air pumps are 50 inches diameter by 40 inches stroke, while the bilge pumps, 7 by 40 inches, are also worked off the low-pressure cylinders.

The usual auxiliaries are fitted, which include one duplex fire pump, one duplex feed pump, one simplex compound feed pump, one duplex sanitary pump, one duplex fresh water pump. In addition, a compound centrifugal fire pump, driven by a Kerr turbine engine, is fitted for supplying water to the sprinkler system, which is automatically controlled.

Eight cylindrical boilers are provided, located in two separate compartments. Their diameter is 13 feet 9 inches, and length 12 feet, each being provided with two Morison sus-



GENERAL PLAN OF THE THREE-CYLINDER COMPOUND INCLINED PROPELLING ENGINE.

one-half and the two lows not much over 25 percent each. This is what led to the adoption of the peculiar combination of valve gear, which is probably the first of its kind attempted in marine work. The result of this arrangement is that each cylinder has a very wide range of expansion, the cut-off point in each cylinder being adjustable from the starting platform at from one-fourth to five-eighths of the stroke. The pressure in the low-pressure receivers can thus be adjusted to divide the total power into thirds.

The inclination of the engine is 3.65 inches per foot. The main crank shaft and crank pins are hollow, measuring 22 inches in diameter, with an axial bore of 8½ inches. The connecting rods are 19 feet between centers, and measure 12 inches in diameter at the crank end, 13 inches at the center and 10 inches at the cross-head end. The piston rod is 10½ inches in diameter. The crank pins are 22 inches in diameter

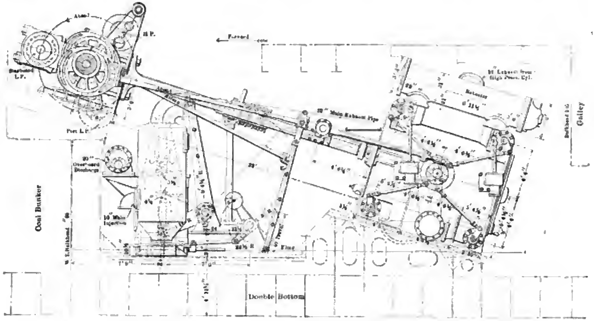
pension furnaces, 52 inches in diameter. The working steam pressure is 160 pounds per square inch. The boilers are worked with the Howden hot-draft system. Two smokestacks are fitted.

Each boiler has a shell in two courses, each course being made of two plates 1 7/64 inches in thickness. The design of the seams shows a plate strength of 80.9 percent of the uncut plate, and a rivet strength of 80.35 percent. Details of riveting are shown on the drawing. In the upper part of the boiler are eighteen through steel stays in three rows; the upper row has stays measuring 2¼ inches in the body and 2½ inches in the screw ends; the others are 2½ inches in the body and 2⅞ inches in the ends. In the region below the furnaces are three through stays measuring 2 and 2¼ inches respectively, with bridge stays between the furnaces and the nests of tubes, measuring 2⅝ and 3 inches. The staybolts,

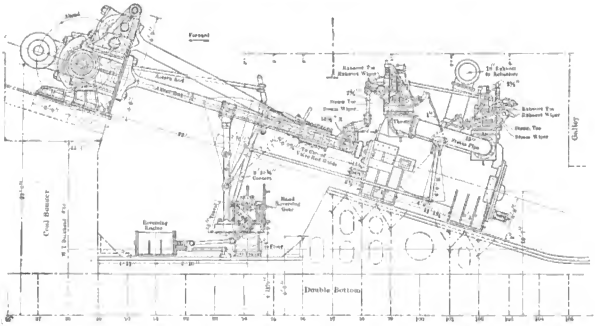
in connection with the combustion chamber, are 1½ inches in diameter, and have 10 threads per inch.

Each boiler contains 360 tubes, with an outside diameter of 2¼ inches. Of this number, 324 are ordinary tubes of No. 12 B. W. G.; the remaining 36 (marked "S") are stay tubes of No. 7 B. W. G. These latter are thickened at both ends to 3 inches and screwed through both tube sheets. The tube sheets are ¾ inch thick in front and 11/16 inch in back. The distance between sheets is 7 feet 11 inches. The back of the combustion chamber is ⅝ inch thick, while the boiler heads, which are flanged, are 1 3/64 inches.

A novel circulating device is arranged, as shown on the drawing. A sheet steel box, 24 by 3½ inches, made of 10-pound plate and angles 1½ by 1½ inches, is attached to the shell of the boiler on each side about midway between the tube sheets. This box starts at the bottom of the boiler and extends to about the location of the waterline. The idea is for water to flow down through these boxes, and thus create a better circulation than would naturally exist through the nest of tubes, unaided by such a device.



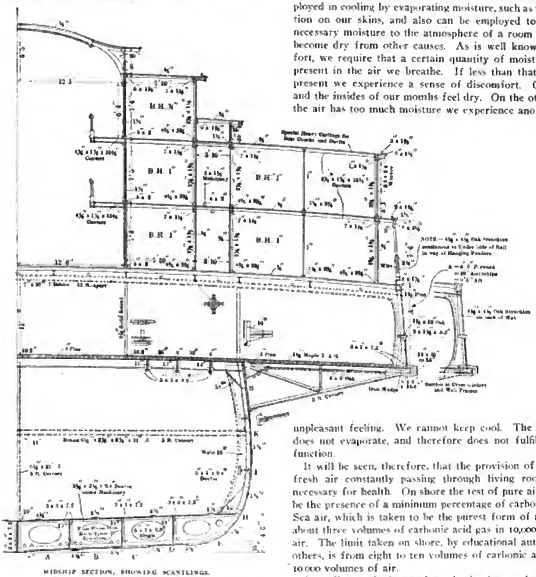
ELEVATION OF THE PORT LOW-PRESSURE ENGINE, SHOWING ARRANGEMENT OF CORLISS VALVE GEAR.



ELEVATION FROM PORT SIDE OF THE HIGH-PRESSURE ENGINE, SHOWING SICKELS CUT-OFF VALVE GEAR.

A condition of the contract for the steamer required her to make an average speed of 20 statute miles per hour over a course on Lake Erie, between South East Shoal Lightship and Long Point, distance 133¼ miles, depth of water 12 to

15 fathoms. The trial was made April 27, and the designed speed was obtained with an average horsepower of 5,717; revolutions, 27.6 per minute; maximum power, 6,622, with 29 revolutions. Since that run revolutions have been increased to 30 under the same conditions.



MIDSHIP SECTION, SHOWING SCANTLINGS.

THE HEATING AND VENTILATING OF SHIPS.

BY SYDNEY F. WALKER, M. I. E. E.

VENTILATION.

In the preceding sections, as explained, the writer has dealt with heating alone, but he has mentioned, from time to time, that heating and ventilating are very closely allied, that you cannot warm any room, for instance, or have any source of heat present in any room, without producing air currents, which necessarily ventilate to a greater or less extent. He now proposes to discuss the question of ventilation by itself, having already shown how the two can be worked together.

Ventilation, as explained in the opening article of this series, is to the atmosphere of any room, or any space in which men have to work or live, what water is to dirt. Atmospheric air has the property of carrying off noxious gases, such as the carbonic acid gas that is given off at each breath by the lungs of men and animals, the exhalations that are constantly being given off from the skin of everyone, the microbes, bacilli, and even the dust that is always present. If a continuous current of air is provided, passing through living rooms, etc., the whole of these should be carried harmlessly away.

In addition to the above, atmospheric air has the property of absorbing the vapor of water, and can therefore be employed in cooling by evaporating moisture, such as the perspiration on our skins, and also can be employed to deliver the necessary moisture to the atmosphere of a room when it has become dry from other causes. As is well known, for comfort, we require that a certain quantity of moisture shall be present in the air we breathe. If less than that quantity is present we experience a sense of discomfort. Our tongues and the insides of our mouths feel dry. On the other hand, if the air has too much moisture we experience another kind of unpleasant feeling. We cannot keep cool. The perspiration does not evaporate, and therefore does not fulfil its natural function.

It will be seen, therefore, that the provision of a supply of fresh air constantly passing through living rooms, etc., is necessary for health. On shore the test of pure air is taken to be the presence of a minimum percentage of carbonic acid gas. Sea air, which is taken to be the purest form of air, contains about three volumes of carbonic acid gas in 10,000 volumes of air. The limit taken on shore, by educational authorities and others, is from eight to ten volumes of carbonic acid in every 10,000 volumes of air.

According to the latest view of scientists, carbonic acid gas has been made more or less of a bogey. From tests that have been made it has been shown that human beings can live, without inconvenience, in an atmosphere containing a very much higher percentage of carbonic acid than that given above. On the other hand, however, it appears to be quite correct in the majority of cases to take the percentage of carbonic acid present in the atmosphere, which can be tested, as a guide for the purity of the atmosphere, with reference to the other matters, organic impurities, etc., that have been mentioned above. But this is not always strictly correct. In the case, for instance, of lavatories, the carbonic acid present may be comparatively small, while the organic matters, as evidenced by the smell, may be comparatively large. The special case of lavatories is dealt with later on.

Ventilation is known as natural or mechanical, according to whether it is left to take care of itself or is more or less controlled. Mechanical ventilation is also sometimes known as either "plenum" or "vacuum." Marine engineers have exactly

the same division in the matter of their furnace draft, natural ventilation corresponding roughly to natural draft and mechanical ventilation to forced or induced draft. Plenum ventilation, which has already been described when dealing with methods of heating air, corresponds to forced draft and vacuum ventilation to induced draft. Natural ventilation can perhaps hardly be said to correspond to chimney draft. It corresponds really to a condition that would be present if there were no chimney.

Perhaps the different methods of ventilation, and the principles of ventilation itself, will be best understood by a reference to the case where it is of the greatest importance, viz.: in coal mining. In a number of coal mines, it will be remembered, as the coal is removed from its bed, gases are given off, which, if mixed with air in certain proportions, will explode and do great damage if a light is presented to them. The explosive mixture is between 5 and 15 percent of the gas in the atmosphere of the mine. When the gas is present in a greater quantity than 15 percent it will not explode, because it cannot contain sufficient oxygen for combination. On the other hand, when the quantity present is less than 5 percent it will not explode, because it is too much diluted with the nitrogen of the atmosphere. These figures apply also to dangers from the vapor of petroleum in tank ships. In the United Kingdom, therefore, successive acts of Parliament have decreed that a certain volume of air shall be passed through all coal mine workings, the volume being sufficient to very quickly dilute, below the explosion point, any gas which comes away. Probably this illustrates, as well as anything, the cleansing action of atmospheric air.

The majority of mines in the United Kingdom, and a large number in the United States, lie wholly below ground, and are reached by two vertical shafts, one of which conveys fresh air to the mine and the other carries off the vitiated air from the workings. From the two shafts, which are named respectively "down cast" and "up cast," two main roads run into the mine, called respectively the "in-take," which extends from the down cast, and which carries the fresh air into the workings, and the "return," which carries the vitiated air from the workings to the up cast. Roadways, or air passages, connect the two main roads in such a manner that there is a constant current of air passing across all working faces from the in-take to the return.

In the early days of coal mining, what would now be termed natural ventilation ruled. The air current was left to take care of itself. Usually the warm, moist, vitiated atmosphere from the workings found its way to one of the shafts, and being lighter than the column of air in the other shaft a certain difference of air pressure was set up between the two, which caused a certain variable and uncertain circulation of air through the workings. It was no uncommon thing in those days for the direction of the ventilating air current to be reversed. In those days also, occasionally, there was only one shaft. It was sometimes divided by brattice cloth into two, the vitiated air finding its way up one half and the fresh air moving down the other half. In some cases even this division was not provided, and the air in those cases formed a division of its own, the warmed air escaping up one side of the shaft while the cold air passed down the other side. The state of the coal mines in those days illustrates very forcibly what natural ventilation really means. Practically there was very little ventilation at all. Any change in the temperature of the atmosphere outside might stop the course of the ventilating current entirely.

The first improvement was the provision of a furnace in the neighborhood of the bottom of the up-cast shaft, which, by providing a column of hot air in that shaft, created what mining engineers call a motive column, by means of which the air from the outside atmosphere passed down the down-cast shaft and through the workings to the up-cast. In most modern coal mines the furnace has given way to the fan, which is usually placed at the top of the up-cast pit. It is placed there principally because the up-cast pit was covered in when furnace ventilation ruled, to prevent the ingress of the colder air to the shaft, thereby neutralizing the effect of the furnace, and it was simpler to make use of the existing arrangements and to adopt the fan to them than to make new arrangements. In a few cases, however, the fan is fixed at the top of the down-cast shaft, and forces air into the mine, the vitiated air, as before, finding its way out through the up-cast shaft. In a few cases, also, the fan at the top of the pit is assisted by fans at the level of some of the seams that are worked from the pit, and also by fans placed in different positions in the workings, to direct the currents of air over particular portions of the working faces, etc.

Marine engineers will recognize a practical counterpart to their own arrangement for supplying their boiler furnaces with air. Furnace ventilation of a mine corresponds to the ordinary chimney draft of a boiler, and fan ventilation corresponds to forced or induced draft, according to whether a pressure or exhaust fan is employed.

The writer would call attention to one very striking feature in connection with mine ventilation, which he thinks will assist marine engineers to follow the work that has been done in the ventilation of buildings, ships, etc. It will be noticed that the shafts, the roads, together with a fan or furnace, form a complete circuit, corresponding exactly to an electric circuit. The shafts and the main roads correspond to the main distributing cables of a two-wire electrical supply service. The branch roads, connecting the working faces with the main roads, correspond to the branch cables or wires connecting lamps or motors to the main supply cables. The furnace, where one is employed, corresponds to a battery, where one is used to supply current, and the fan corresponds to an electric generator.

The correspondence is even closer than this. Just as successive coils of wire, passing through the magnetic field of a dynamo machine, produce successive increments of electrical pressure, so the passage of the successive blades of a fan produce successive increments of air pressure. Further, air encounters resistance in its passage through a mine, just as an electric current encounters resistance in its passage through a conductor, and the resistance in both cases varies directly as the length and inversely as the sectional area. Thus, the greater the length of the main roads of a mine through which the air current has to pass, the greater is the resistance offered to its passage, and the greater must be the air pressure, measured in water gage, to overcome it. Also, the larger the air passages the less is the resistance offered.

The latter statement will appear at first sight to be incorrect, inasmuch as the resistance to the passage of air through any roadway, pipe or duct depends directly upon the friction of the air against the sides of the duct, roadway, etc., and evidently the larger surface of the larger road will create more friction than a smaller surface of a smaller road. But there is another factor in the problem in connection with air. The resistance offered to its passage varies as the square of its velocity, and its velocity increases with a given air delivery as the area of the road or duct through which it passes is reduced; and, therefore, though the increase of the size of the road or duct increases the friction offered by the surface, the total resistance is considerably lessened, because the velocity is also lessened.

And all this applies to the ventilation of buildings, of ships, etc. Modern ships in particular correspond in a great many respects to the modern coal mine in the matter of ventilation. The modern ship is divided into compartments by athwartship bulkheads, and in the case of very large ships like the

Lusitania by fore-and-aft bulkheads. It thus becomes necessary to deal with each compartment, from the topmost deck, downwards, by itself. In the *Lusitania* two compartments that are abreast sometimes communicate by watertight doors, as in the case of the electrical engine room, and while the doors are open they can be dealt with as one; but the separate compartments as a rule have to be dealt with separately, and, just as with a coal mine, all the fresh air has to be brought from the surface, in this case the deck, and the vitiated air must be carried off, either on the same deck or at some point where it will not mingle with the air that is going down below.

The ventilation of ships has gone through very much the same course of development as the ventilation of mines. In the early days it was left to take care of itself, open hatches and open ports being trusted to do the work. Later on the equivalent of furnace ventilation was established, ducts being led into the holds, mess rooms, saloons, etc., the other ends of the ducts being carried to the neighborhood of the funnel, and the circulation of the air being set up by the heated column of air produced by the hot gases in the funnel, fresh air being allowed to enter by cowls and other arrangements provided for them.

In the early days of heating and ventilating of ships compressed air was used in some cases to provide suction of the air out of the hold and between decks on the well-known injector principle, fresh air being allowed to find its way down below by air inlets something on the lines of the cowls that have been mentioned; but all these systems have given way to the use of the fan, since electricity has been established on board ship and the convenience of the electrically-driven fan has been appreciated.

Another point of importance should be noted here. It is absolutely necessary that there shall be a complete circuit wherever ventilation is to be carried on. In the case of the coal mine, the circuit is from the atmosphere, say at the entrance to the down-cast shaft, through the down-cast shaft, the in-take airway, the branch roads, the return airway, the up-cast shaft to the atmosphere again. In the case of the air supply of a boiler furnace, it will be remembered, there is the same circuit. From the atmosphere, by various passages to the stoke hole, through the ashpit, the fire bars, the fuel, the fire tubes, the up-take and the funnel to the atmosphere again. Just as with an electric circuit, if the circuit is broken, or if the passage of the current is cut off, the working of the apparatus the current operates is also stopped; so if the ventilating circuit is broken at any point, if the passage of the air current is cut off by any obstruction, the working of the ventilating air current is also stopped. Further, just as with an electric circuit, if a resistance is introduced into the path of the current the strength of the current itself is reduced with any given pressure, so if any obstruction is introduced into the path of the air current, whether for ventilation or for a boiler furnace, the strength of the air current, with any given air pressure is reduced.

It was mentioned above that the resistance offered to the air current depends directly upon the length of the path through which the air has to move, and inversely as the sectional area of the path. In other words, the smaller the duct through which the air supply is carried the greater is the resistance offered to its passage, and this means that the greater is the pressure which has to be employed in delivering the air current, and the greater the velocity of the air current itself. In this matter the ventilation of ships is at a disadvantage compared with the ventilation of buildings on shore and with that of mines, though the advantage is not often taken full advantage of on shore.

For perfect ventilation, and for the avoidance of what is known as a draft, the air should circulate with a very low velocity, from 3 to 5 feet per second, but in order to do this the ducts through which it circulates must be large, and on board ship, even in the very largest liners, it is not possible to allow a sufficient space; as usual, a compromise has to be effected. The ducts have to be made as large as the other requirements of the ship will allow, their length as short as can be conveniently arranged, and the requisite current of air must be made up by increasing the velocity as required.

A striking instance of what may be done by the provision of large ducts will probably make the matter clear. At the Birmingham General Hospital, where the plenum system has been carried out very carefully under the direction of an able architect, it is not possible to feel any draft anywhere. The whole of the building is subject to a very gentle air current, and as one passes from corridor to ward, or ward to corridor, one is absolutely unconscious of any change. Those who have visited the usual run of hospitals, where the windows are kept wide open on the stairs, while the wards are kept warm in winter, will have sometimes a painful experience of the great change in the temperature between a ward and the landing outside.

Further, at this hospital, the smells that are so often in evidence, such as those of dinner, of medicines, etc., are absolutely unknown. Everyone will be familiar with the unpleasant smell there always is about a restaurant immediately after dinner, and usually also in the neighborhood of the wards of a hospital while dinner is going on and immediately afterwards. One can frequently tell, a little way off, if cabbage is an article of diet, and so on. At the Birmingham General Hospital there is no sign of anything of the kind. The ventilating air current carries off all odors, just as the ventilating current of a coal mine carries off the explosive gases. And this effect is produced with the expenditure of a very small amount of power—20 horsepower only—and with an air pressure of only 1/20-inch water gage. Marine engineers hardly need reminding how very small a pressure this is.

At Birmingham the result is produced by very large ducts. In the main duct a dozen men can stand abreast, and there is almost head room for a man to stand on another man's shoulders to reach the ceiling. The branch ducts are in proportion, and the result is as described. As against this the ventilating air current of the majority of coal mines, though the airways in the best of them are wide and high, is very powerful indeed, and it is a serious source of danger to working miners coming from the coal face, where, in spite of the air current, the temperature in deep mines is very high indeed, and where their physical exertion causes profuse perspiration, for them to come out into the cold air current of the main roads.

As explained above, it is not possible to provide large ducts, even in the largest ships, for ventilating air currents; but, on the other hand, the lengths of the ducts, even those leading to the lower decks, is not great.

As mentioned above, the ventilation of ships has settled down to the motion of the air by fans just as has the ventilation of coal mines, and just as the tendency of modern boiler work is to provide either forced or induced draft by the aid of fans. As with coal mines, also, and as with boiler furnaces, the air may be forced into the space to be ventilated by a pressure fan, the vitiated air being allowed to escape by any convenient outlet, or the air may be exhausted from the space to be ventilated by a suction fan, and fresh air drawn into the space through any convenient inlet. The one thing to remember in all cases where efficient ventilation is sought is that there must be an inlet and an outlet, and that the same quantity of air which passes in must pass out.

A point that should be noted here is that where the space to be ventilated is also heated, whether the air is heated artificially on its way to the space, or whether it is heated in the space, either artificially or by the presence of men or

animals in the space, the volume of air passing out will usually be greater than that passing in, and therefore the outlets should have a larger area than the inlets. The problem in this case is the same as that in connection with both mine ventilation and the supply of air to a furnace. The fan supplying induced draft, it will be remembered, must be larger, in the sense that it will allow a larger volume to pass through it than the fan required for forced draft, because the volume of the hot gases is larger than the volume of the air that is to be delivered to the fan. In the case of the ventilation of saloons, cabins, etc., the difference in volume of the air will usually not be great, but the caution given above should be remembered, in order that those who are responsible for the designing of systems of ventilation for ship-board work should be careful not to make the outlets smaller than the inlets. Making either an inlet or an outlet small throttles the passage of the air through it, increases the pressure at which the air has to be driven through the space to be ventilated, and increases the tendency to drafts.

For ventilation, therefore, whether of the between decks where cattle are carried, the large living spaces where steerage passengers are carried, or the saloons, staterooms, or officers' cabins, the same principle holds good. Air must be brought from the deck to the space to be ventilated, and the vitiated air must be allowed to find its way back to the deck or to the outside of the ship. In some of the White Star liners air is brought down from the deck under pressure, is directed through ducts into the staterooms, and is allowed to escape through the ports of the staterooms, saloons, etc., when the ports are open, and when the ports are not open the air escapes by a duct provided specially for it, opening into the the ship on the inside, and opening into the atmosphere on the outside of the ship, but protected by a valve on the outside, which is open when the sea does not rise to it, but which closes automatically when the ship rolls and dips that end of the duct or if the sea washes up to it. The writer understands that this method is giving way to the system that has been worked out by the Thermotank Company, in which all air is taken from the deck and returned to the deck.

In the case of cabins, staterooms, etc., opening to the atmosphere, such as those on the upper decks, boat decks, etc., where there are any, the system of ventilation can be modified. Air may be taken in or expelled from the side of the cabin, but provision must be made for the exit of the air. In the *Lusitania*, in some of the cabins on the upper deck, an adjustable inlet is provided for the air in the side of the cabin, and it is exhausted by a duct leading to the boat deck, a small electrically-driven fan providing motive power for the air when required.

In some of the cabins on the boat deck of one of the White Star liners the writer noticed another ingenious method of ventilation, based upon the injector principle. A T-shaped pipe was fixed on the side of the cabin, the central portion, the stem of the T, projecting into the cabin, and the top, or cross, of the T being arranged fore and aft outside of the cabin. As the ship goes through the water air rushes through the portion of the pipe outside of the cabin, and draws air through the connecting piece leading to the cabin, causing a current of air to pass out of the cabin, through the after portion of the fore-and-aft piece. This would probably make a very efficient ventilating arrangement, but it must again be remembered that some method of providing the inlet air must be arranged or the ventilation cannot go on. The inlet air may be provided by a protected duct leading to the deck above, or in any other convenient way.

VENTILATION AND HEATING AND COOLING.

The connection between heating and ventilating has already been explained, and that between cooling and ventilating to a certain extent. It will be understood, from what has been said, that once possession is obtained of a current of air passing continuously through a room, a saloon, mess room, cabin, etc., it can be employed for warming the room, cooling it, providing it with moisture, or reducing the moisture present by merely placing the heating, cooling, humidifying or drying apparatus in the path of the air current, and by properly proportioning the heat supplied, the heat extracted, or the moisture supplied or extracted, to the requirements of those occupying the room. Also, it will be understood that, with properly arranged apparatus, it should be possible to vary the heating, cooling or moisture at will in each compartment dealt with.

VENTILATION OF LAVATORIES AND CATTLE SPACES

The ventilation of lavatories and between the decks where cattle are carried presents some difficult problems. So far as the writer is aware the between decks for cattle have not been subject to any special method of ventilation, but lavatories

FIG. 66.—SIMPLEX OZONE PRODUCER, EXTERNAL VIEW.

have, and in his opinion the between decks for cattle, and even in some cases the steerage quarters, might with advantage be subject to the apparatus to be described. The difficulty in the matter of ventilation in these cases is the effluvia that is too often present, and that even a powerful ventilating current sometimes fails to get rid of.

The remedy appears to be the addition of ozone-making apparatus to the ordinary ventilating current. Ozone, it will be remembered, is oxidized oxygen. Its chemical symbol is O_3; oxygen in the ordinary way usually combining only as O_2. Ozone is the great vivifying agent that is so much sought after by invalids who take sea passages and who go to the seaside. It has a very peculiar and by no means a pleasant odor. It may be smelt, especially in the early morning, on open hill sides, and on the decks of ships at sea, and again at the seaside, in particular, close down to the water's edge.

It is oxygen in a very powerful condition, and its office is to oxidize, that is to say, to burn up the microbes, bacilli, etc., which produce the offensive effluvia and which will cause disease if allowed to remain. Ozone is produced by electricity. It may always be smelt by those who know its characteristic odor after a thunder storm. It is created in fairly considerable quantities by every flash of lightning, and by the silent discharges which take place during thunder storms which do not give rise to lightning. It is

created industrially by the aid of high-tension alternating currents, combined with what are called electrical condensers. The electrical condenser is quite different from the steam condenser. Every electric cable is an electrical condenser. Whenever two conductors are close together, but separated by an insulator, an electrical condenser is formed by them, and if an electric current is delivered to one conductor a charge of electricity is delivered to and absorbed by the insulating substance separating the two conductors.

For ozone-making apparatus condensers are formed sometimes of glass tubes with conductors arranged inside and out, and sometimes of glass plates, with sheets of metal foil between. In the Anderson apparatus, which is illustrated in Figs. 66 and 67, the condenser consists of the glass tubes shown, with conductors in the form of coils of wire on the outside and other conductors on the inside. In all electrical condensers one of the conductors is connected to earth, in this case to the body of the ship, and a high-tension alternating current is delivered to the other conductor. The condenser is arranged to be placed in the path of an air current, and the constant charge and discharge of the electrical condenser, produced by the passage of the alternating current, converts ozone into the oxygen of the air passing through it, the ozonized air being then delivered wherever it is required.

FIG. 67.—SIMPLEX OZONE PRODUCER, AS SUPPLIED TO WHITE STAR STEAMERS BY THOMAS ANDERSON.

The high-tension current is produced on shore by the alternating currents of the ordinary town supply service, raised to very high tension—several thousand volts—by means of stationary transformers, similar to those that are used for the distribution of high-tension currents. Up to the present, so far as the writer is aware, alternating currents have not been employed on board ship, and therefore some arrangement is necessary for converting the continuous currents to alternating. This may be done by means of small motor generators, consisting of two distinct machines, a continuous-current motor taking current from the lighting or power service of the ship, and an alternating-current generator, whose armature is driven by the electric motor. The alternating current can be transformed by a stationary transformer to the high pressure necessary.

Another method which has been adopted by Mr. Anderson in his apparatus, and which it is claimed answers the purpose, is to employ the continuous current taken from the lighting or power service of the ship and to subject it to very rapid interruption, very much on the lines of a trembler bell or the induction coil employed with motor cars. A special form of interrupter is used and a charge and discharge of the electrical condenser is obtained, this giving rise to the ozone required, which is directed where it is wanted. In use the ozone generator must be placed in the path of the air current that is to circulate through the lavatory or other space to be dealt with, the ozonized air being allowed to circulate through the space, and the resultant air being carried off by a separate duct in the usual way.

(To be continued.)

THE MOTOR BOAT GUIDE, OF THE UNITED STATES REVENUE CUTTER SERVICE.

The United States Revenue Cutter Guide.

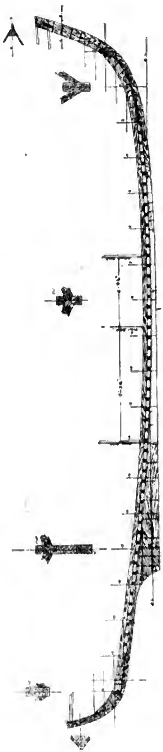
This 70-foot twin-screw launch, equipped with two 60-horsepower standard engines, has just been completed by the Electric Launch Company, Bayonne, N. J., for the United States Treasury Department, for anchorage service in New York harbor and vicinity. This is the first revenue cutter to be equipped with gasoline (petrol) motors, all boats heretofore being equipped with steam boilers and engines.

The *Guide* is 70 feet in length, 13 feet 6 inches beam, and 4 feet 6 inches draft. Her displacement is 27 tons. The hull is of substantial construction, oak frame, cedar planked, copper

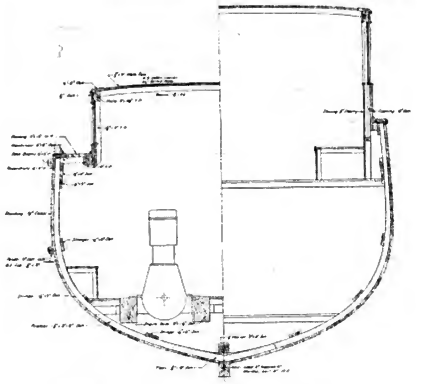
in number, made of heavy galvanized steel, with a total capacity of 1,000 gallons. The weight of tanks when empty is 3 tons.

Two steel bulkheads separate the engine room from forward and after quarters. Large space is provided for the installation of the two four-cylinder engines, which are capable of driving the boat at a speed of 12 miles an hour. A complete electric light plant is installed, with storage battery auxiliary power; electric lamps being placed throughout the boat, and a powerful searchlight on the pilothouse roof.

The after saloon is 12 feet in length, with side transoms, giving sleeping accommodations for four officers, with mahogany writing desk, toilet and lavatory compartments. Side decks are provided around the cabin house, with spacious bridge deck, permitting the boat to be handled from outside. The cabins are inclosed by plate-glass windows, dropping down into pockets and giving free ventilation and air throughout.



KEEL DETAILS OF THE NEW MOTOR-PROPELLED REVENUE CUTTER GUIDE.



MIDSHIP AND SCANTLING SECTION OF THE GASOLINE CUTTER GUIDE.

fastened throughout; pilot and cabin house finished outside in quartered oak; interior in oak with mahogany trim and furniture. A spacious forecastle is provided forward for a crew of four men, with large galley in peak. The full width of the boat makes a spacious cabin for dining and officers' quarters. Side transoms are placed, providing for two berths, with large mahogany sideboard and lockers. The boat is steered in pilot house as well as on bridge deck. The gasoline tanks are installed under the flooring of the pilot house, four

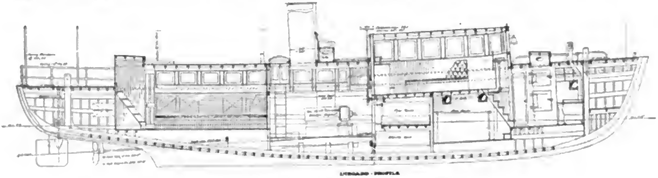
The requirements under which the vessel was built were somewhat onerous, involving the fitting of a very large amount of material, and the provision of many pieces of equipment and comfort not usually found in vessels of this size. Among other such features might be mentioned a watertight door (really a vertical manhole), with a clear opening of 14 by 20 inches, located on the steel bulkhead just forward of station No. 9. This door measures over all 18 by 24 inches, and is held in place by sixteen ½-inch studs. The door itself is made of 10-pound plate, while the bulkhead is of 7-pound plate. The overlap of the door upon the bulkhead is 2 inches all around, the opening in the bulkhead being stiffened by ⅜-inch bars, covering this space of 2 inches. Between the bulkhead and the door is a rubber gasket, which provides for watertightness when the studs are screwed up hard. The bulkhead itself is stiffened by wooden studding, measuring 1¾ by 3 inches.

A 12-foot boat is carried in chocks on the deckhouse aft of amidships, and may be swung out by means of davits. Forward

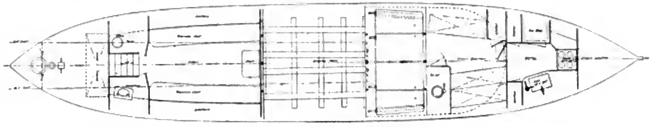
of this is the elliptical galvanized steel funnel, measuring 34 by 24 inches, and used for ventilating the engine room. The pilothouse, still further forward, is set down into the hull, and includes a steering station, a cupboard, a buffet and two sofas. It is 15 feet in length. Three flights of stairs, two leading aft to the deck above, and one leading forward to the forecastle, open into this apartment. The entire house, with the exception of the after end, is fitted with windows. Underneath this pilothouse, as shown by the inboard profile, are found quarters for the crew in the forward end and fuel and whistle tanks in the after end.

The entire construction is very heavy, all the metal fittings being of bronze and galvanized steel, to withstand the severe service which a boat like this meets with in boarding vessels entering New York harbor. The boat is built and designed for business all the way through, and is in construction equal to the heaviest steam vessel of her size.

The trial trip of the boat, March 30, was very successful, the engines developing their full power for a period of two hours.



INBOARD · PROFILE



ARRANGEMENT · PLAN

INBOARD PROFILE AND GENERAL ARRANGEMENT PLAN OF THE U. S. REVENUE CUTTER GUIDE.

THE MOST SUCCESSFUL DIMENSIONS OF STEAMSHIPS IN RELATION TO ECONOMY.

BY OTTO ALT, DIPLOM-INGENIEUR.

The moment of the forces produced by the static unequilibrium is to be added to the moment defined in equation (25). For simplicity, only the beam C A may be added, and considered a strut to support the frames (Fig. 6). The reaction produced in this way may be calculated only by means of the laws of stresses of materials. Of course, it is dependent, too, on the dimensions, in some way, but such investigations are not yet available.

The whole moment, acting on B, is

$$M_0 = M - Z \times h, \qquad (28)$$

where M has the value shown in equation (25).

Speaking of midship sections more complicated, for instance, Fig. 2, generally,

$$M_0 = M - M_x, \qquad (29)$$

where M_x means the moment of the unknown statical values.

The stress which will not exceed a certain sum is given by the equation:

$$p = \frac{M_0}{r} \qquad (30)$$

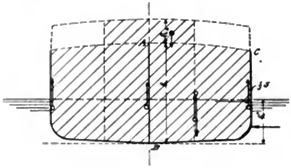


FIG. 6.

The value of the weight may then be indicated, only in case there are certain suppositions on the form of the beam on account of the moment of resistance. Starting from a channel section (see Fig. 7) it may be

$$r = \frac{s \times h_0}{3} (3b + h_0), \qquad (31)$$

and the weight of the floor will be

$$w_1 = c_0 \, B \, (2b + h_0) \times s \qquad (32)$$

where c_0 is a coefficient.

Then there results from (30) and (32)

$$w_1 = c_0 \times \frac{B}{h_0} \times \frac{2b + h_0}{3b + h_0} \times M_0. \qquad (33)$$

FIG. 7.

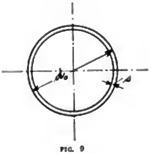


FIG. 9

From this relation several most interesting and important conclusions result in case the value of M_0 is introduced. This will be mentioned elsewhere. All the other transverse structural arrangements, the beams, the stiffening bars of bulkheads, etc., may be managed in the same way, after having found out the bending moment in any direction according to the laws of the theory of elasticity.

The problem of the strength of local structure is yet only beginning to be understood. Therefore, we must try to employ what is known already. According to the experiments of C. Bach,[10] the thickness of plating is to be found from the relation (cf. Fig. 8):

$$s = 0.224\, l \times \sqrt{\frac{\mu \times d'}{\left(1 + \left(\frac{l}{a}\right)^2\right) p}} \tag{34}$$

where μ is a coefficient and d' indicates the mean depth of water, on which the part of bulkhead in question is to be found.

In order to show the dependence on the fundamental dimensions, l is to be set like frame spacing or space of stiffeners; that is to say, either a dependence on the length or on the breadth; and d' is to set like d, and a like the distance of horizontal girders; that is to say, depending on the depth.

Then the weight for a square is

$$w_5 = x \times l \times a \times s \tag{35}$$

where x is the constant of weight (fundamental constant) or with (34),

$$w_6 = D_0 \times l^2 \times a^2 \times \sqrt{\frac{\mu\, d'}{a^2 + l^2}} \tag{36}$$

a being very great in proportion to l, then

$$w_5 = D_0 \times l \times a \sqrt{\mu\, d'}. \tag{37}$$

In connection with the formula for the weight of stiffening bars, this formula shows which choice of the distance of stiffeners will be the best for the weight.

Usually in shipbuilding only such parts are examined in reference to the racking stress, the racking force of which results from the Eulerian formula for the straight column. For a pillar, for instance, a moment of inertia results from the racking charge

$$Q = c' \times \frac{E \times I}{l_0^2}.$$

E = Young's modulus, l_0 = length of column,

$$I = \frac{Q \times l_0^2}{c' \times E}.$$

l_0 depends on the dimensions. A hollow cylindrical section being supposed, it will approach (Fig. 9)

$$I = \frac{\pi}{8} \times d_0^3 \times s, \tag{39}$$

and the weight of the pillar

$$w_5 = x \times \pi \times d_0 \times s \times l_0 \tag{40}$$

from the relations (38) to (40), there results:

$$w_5 = F_0 \times \frac{Q\, l_0^3}{d_0^2}. \tag{41}$$

For other forms of cross section, analagous formulas, which may be easily derived, may be found.

The examination will get more difficult as soon as the question comes up of the racking stresses of plates. Therefore, only the case may be considered which exists, in case the deck plating is submitted to a pressure at the longitudinal seams. Then, according to A. E. Love,[11] for special racking forces the relation exists:

$$p = \frac{Q}{F} = \frac{4\pi^2}{1 - \mu^2} \times \frac{E \times I'}{l^2}.$$

μ = Poisson's proportion, l = frame spacing. Q = the whole pressure acting on the deck, F = cross section of deck plat-

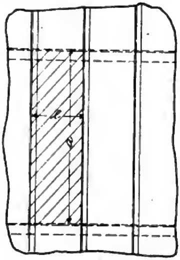


FIG. 8.

ing, I' = moment of inertia of a cross section with unit length. Then the moment of inertia is given by the relation:

$$I' = \frac{p\,(1 - \mu^2) \times l^2}{4\pi^2 E}, \tag{42}$$

l and I' depend on the dimensions, here, too; thus

$$I' = \frac{s^3}{12} = \frac{Q\,(1 - \mu^2)\, l^2}{B \times s \times 4\pi^2 \times E}, \tag{43}$$

and the weight of the deck plating over a frame space

$$w_6 = x \times B \times s \times l. \tag{44}$$

In a similar way as above, there results

$$w_6 = F_0' \times l^2 \sqrt{Q \times B^2 \times l^2}. \tag{45}$$

In order to find out the whole weight of the hull, W_1, in its dependence on the dimensions, the variations of all the single parts are to be considered. The above gives only an indication.

In order to find out the variation of the weight of machinery with the dimensions, we relate it—as is always done—to the horsepower and to the weight per unit of horsepower:

$$W_2 = \gamma_0 \times I\,H\,P.$$

The γ_0 of this relation can have most varying values, according to the kind of engine (steam engine, steam turbine, gas engine), to the boiler arrangement (tubular boiler, water-tube boiler) and to their special building. We will refrain from investigating this.

Above all, the question is for a variation of the indicated horsepower with the fundamental variables. According to the usual methods, the power

$$I\,H\,P = y_m \times y_p \times E\,H\,P \tag{46}$$

when y_m, y_p mean the mechanical efficiency of the engine and of the propeller, and $E\,H\,P$ means the effective power of the propeller.

At first we consider the dependence of $E\ H\ P$ on the dimensions, and, referring to the formula

[10] Elastizität und Festigkeit, Berlin, 1902, page 598.

[11] Treatise on Elasticity, Cambridge, 1892, Vol. II., §381.

$$R = \frac{E\,H\,P}{C \times V}, \text{ } C \text{ being constant,}$$

we go back to the ship's resistance. Froude has shown in his essay of 1874 that—in order to judge of the question of the "useful displacement"—the dependence of the ship's resistance on the dimensions must be known. It is very interesting to see the progress made in this direction since those days. It is a fact that our knowledge of the "curve of resistance for the ship of each proportion"—as Froude defines it—is a very incomplete one still to-day. We have in this direction principally the researches of G. Rota,[12] who has studied the dependence of the resistance on the dimensions, it is true, but only for one single block coefficient δ, especially for $\delta = 0.5$. In a considerable way these researches were completed by R. E. Froude,[13] who undertook besides this another variation of δ, between limits of 0.4865 and 0.541. But these values are only very rarely used in the building of merchantmen. Besides, some time ago D. W. Taylor[14] published the results of some experiments about the dependence of the resistance on the block coefficient. But these data, given for a battleship, permit only a limited employment for our purpose.

The enormous material that has been collected in the dozen model basins of the different civilized nations is entirely useless, for the greater part, in this question, because usually experiments are undertaken only as far as necessary to gain most favorable lines after having fixed the dimensions.

The better-known fomulas of resistance which have been found have been compiled by W. Johns[15] some time ago; but they do not serve us well, considering our purpose. A great many of the formulas, for instance the French formula

$$I\,H\,P = \left(\frac{V}{m}\right)^3 \times \text{midship section,} \tag{47}$$

and the English Admiralty formula

$$I\,H\,P = \frac{V^3 \times W^{2/3}}{C}, \tag{48}$$

show only a very limited variation of the $I\,H\,P$ in changing the dimensions.

Those formulas are more available which separate the resistance into frictional resistance and residuary resistance. But even comparing these formulas with Rota's experiments large mistakes have been prevalent. Perhaps the best formulas for use are those given by D. W. Taylor.[16]

(1) For the frictional resistance:

$$R_1 = f \times S \times V^{1.83}. \tag{49}$$

S being equal to $C \times \sqrt{W\,L}$, and

(2) for the residuary resistance:

$$R_2 = \frac{12.5 \times W \times \delta \times V^4}{L^2}. \tag{50}$$

In the first formula C is a coefficient dependent on the proportion B/D. Besides this, the frictional coefficient f is dependent on the length L, as is known. In this formula the fact is very interesting that the frictional resistance increases porportional to $\sqrt{\delta}$ only, while the displacement—and therefore the carrying capacity—grows proportional to δ. As for the rest, there are no certain conclusions for variations, as has been proved in several cases. For instance, in the formula (50) a dependence on the dimensions B and d is not to be found, while Rota has shown one as being a fact.

The performance of the machinery is not thus influenced very much in equation (46), but surely such a dependence exists in the efficiency of the propeller η_P—especially on the draft and on the block coefficient—and this is partly proved by model experiments. Such a dependence is explained easily by differences in the stream lines, *i. e.*, in the speed of the water entering the propeller. There are no experiments in this direction as yet. D. W. Taylor's[17] experiments, the most comprehensive of all, have no direct bearing on this question. Similar it is with the paddle-wheel; here such a dependence exists by virtue of its position and the height of the wave attending the ship.

The weight of fuel W_4 depends generally on the fundamental constant γ_4, of the weight of fuel used per indicated horsepower per hour, on the duration of the voyage, and on the amount of the indicated horsepower. Only these latter are variable with the dimensions, and this in a way which has already been discussed above. As with the fundamental constant γ_1 there are quite similar considerations with regard to γ_4. Here the question of oil fuel, already sufficiently discussed, figures prominently.

The weight of fittings and stores and of equipment varies with the dimensions, too, and this is often caused by the variation of some value already discussed. The different sized surfaces which are to be covered over, the equipment of large and of small rooms, cause variations in the weight, which must be examined in each detailed case. The questions referring to this are mostly of but secondary importance.

There is not much to be said about the other values in equation (15). These values vary from yard to yard with each shipowner and each ship designer, and cannot be considered in a general way.

Perhaps this treatment of the problem of profit is conducive to the usual conclusion of compromises; the empirical seeking for the maximum of profit. Pure examination shows that the attainment of a maximum of profit is given ideally by physical laws and the laws of economy, but that this leads to analyses, most detailed and wasteful of time. Such examinations have a great value only when the opening of a commercial province, distinctly limited, is to be undertaken by a shipowner. In such case the question is to find out, for this determined purpose, a type of ship which tallies with the conditions given above. In this case this type of ship is to be produced in great numbers, so that the profit of such a productive association may be increased in a very considerable way. This method allows interesting prospects for a future enlargement of express steamers—a problem that, at different times, has engaged the attention of shipbuilders.

Finally, I might mention that an examination, brought about by myself according to the above principles, for a tank steamer of 13900 tons displacement, and of a speed V of 11.5 knots, at a δ of 0.80, showed that the proportions

$L/B = 7.8$ to 8.0; $d/B = 0.45$ to 0.50 and $D/B = 0.56$ to 0.64 characterize the most profitable result.

[12] *Bulletin de l'Association Technique Maritime*, 1900, page 49, and Transactions Institute Naval Architects, 1905, page 384.

[13] Transactions Institution Naval Architects, 1904, page 157.

[14] INTERNATIONAL MARINE ENGINEERING, page 263, July, 1907.

[15] *Engineering*, 1907; also INTERNATIONAL MARINE ENGINEERING, page 261, July, 1907.

[16] Transactions Society Naval Architects and Marine Engineers, 1898, page 226, and 1903, page 243.

[17] Transactions Society Naval Architects and Marine Engineers, 1904, page 107, 1905, page 84, and 1906, page 65.

The number of vessels entered at the port of Yokohama during 1907 was 1,195 of 3,489,822 tons, as compared with 1,062 vessels of 3,276,949 tons in 1906, and 924 vessels of 2,847,031 tons in 1905. The vessels cleared in 1907 numbered 1,110 of 3,303,096 tons; in 1906, 1,052 of 3,240,973 tons, and in 1905, 894 of 2,760,303 tons.

TRIAL PERFORMANCES OF THREE UNITED STATES SCOUT CRUISERS.

Three scout cruisers were authorized by Congress in 1904, and contracts were signed in May of 1905 for their construction. They have just been delivered to the government. While not representing any large military value, these scouts are of great interest from the fact that the three have totally different modes of propulsion, one having the ordinary reciprocating engine; a second, Parsons turbines; while the third has Curtis turbines.

The three ships were given a general description at page 254 in our issue for June, 1905.* Each has a length on the waterline of 420 feet, or 423 feet 1 inch over all; a beam on the waterline of 47 feet 1 inch; and the normal displacement on a draft of 16 feet 9 inches is 3,750 tons. At this displacement, which corresponds with that obtaining on trial trip, the vessels carry 50 tons of feed water and 475 tons of coal, this latter figure being considerably greater than the total bunker capacity of each of the eight British scouts built three years ago. The full bunker capacity of the present vessels is 1,250 tons, and the full load displacement 4,687 tons. Under this condition the draft is 19 feet 1½ inches. With a designed horsepower of 16,000, the contract trial speed of each ship was 24 knots, to be maintained for four hours, in addition to which a number of other tests were prescribed. Each ship has four small funnels, the two center ones being circular in cross-section, while the end funnels are elliptical.† The boiler equipment consists of twelve units in three fire rooms, each containing four boilers. The forward and after funnels serve respectively the forward and after pair of boilers in the forward and after fire rooms; the second funnel serves the after pair of the forward fire room, and the forward pair of the central fire room; the third funnel serves the after pair of the central fire room and the forward pair of the after fire room.

In order to insure the ability of these ships to maintain high speed at sea during all conditions of weather, they have been given a very considerable freeboard, amounting to no less than 34 feet at the bow, 21 feet 6 inches at the stern and 19 feet 8 inches amidship, on normal draft. Each vessel carries two 5-inch rapid fire guns, mounted on the forecastle and poop respectively, and six 3-inch guns amidships. In addition there are two 21-inch submerged torpedo tubes.

The main feature of interest is naturally in the machinery, opportunity having been afforded in this particular case for a thorough testing of three different types of propelling engine under identical conditions. It is the intention of the government to inaugurate a series of races or trials, side by side, thus deriving data in addition to the very considerable amount of information obtained by the regulation trial trips, which occurred during February, March and June of this year.

THE AMERICAN SCOUT CRUISER CHESTER, STEAMING AT OVER 26 KNOTS ON FOUR-HOUR OFFICIAL TRIAL TRIP.
(Copyright, 1908, N. L. Stebbins.)

The *Birmingham*, built by the Fore River Shipbuilding Company, Quincy, Mass., is fitted with twin screws, operated by vertical triple-expansion four-cylinder engines, the cylinders being 28¼, 45, 62 and 62 inches in diameter, with a stroke of 36 inches. The revolutions at full power are about 190 per minute. The twelve boilers are of the Fore River type, with a grate surface at 696 square feet and heating surface 37,992 square feet, the ratio being 54.5 to 1. Each engine is located in a separate watertight compartment and is furnished with steam at a pressure of 250 pounds per square inch.

The *Chester*, built by the Bath Iron Works, Bath, Maine, is fitted with four screws, operated by six Parsons turbines, the revolutions at full speed being about 600 per minute. Each outer shaft has a high-pressure turbine, while the inner shafts are fitted with two turbines each, one being the low-pressure and the other a cruising turbine. The astern turbines are located, as usual, in the after end of the low-pressure casing. The starboard inner shaft carries the high-pressure cruising turbine, and the port inner shaft the intermediate-pressure cruising turbine. At low speed these two turbines are used in conjunction with the two low-pressure turbines, on the same shafts. Steam is furnished by Normand water-tube boilers; the feed heaters are also of the Normand type, there being one end-pressure heater in each of the two engine rooms. The boiler heating and grate surfaces are 32,040

* And the *Salem* at page 410, October, 1907.

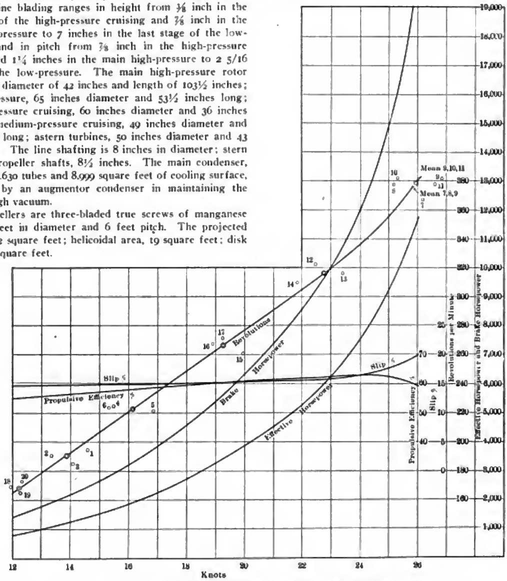
† Except in the *Chester*, where circular funnels with small inner tubes are fitted.

and 696 feet, a ratio of 46 to 1. The steam pressure is 250 pounds per square inch. Each boiler, with water for steaming, weighs 19.7 tons. The entire machinery weights come slightly under the stipulated limit of 798 tons. The funnels, 6 feet in diameter, stand 63 feet 3 inches above the grates.

The turbine blading ranges in height from ⅜ inch in the first stage of the high-pressure cruising and ⅞ inch in the main high-pressure to 7 inches in the last stage of the low-pressure; and in pitch from ⅞ inch in the high-pressure cruising, and 1¼ inches in the main high-pressure to 2 5/16 inches in the low-pressure. The main high-pressure rotor drum has a diameter of 42 inches and length of 103½ inches; the low-pressure, 65 inches diameter and 53½ inches long; the high-pressure cruising, 60 inches diameter and 36 inches long; the medium-pressure cruising, 49 inches diameter and 60½ inches long; astern turbines, 50 inches diameter and 43 inches long. The line shafting is 8 inches in diameter; stern tube and propeller shafts, 8½ inches. The main condenser, which has 5,630 tubes and 8,999 square feet of cooling surface, is assisted by an augmentor condenser in maintaining the requisite high vacuum.

The propellers are three-bladed true screws of manganese bronze, 6 feet in diameter and 6 feet pitch. The projected area is 17.02 square feet; helicoidal area, 19 square feet; disk area, 28.27 square feet.

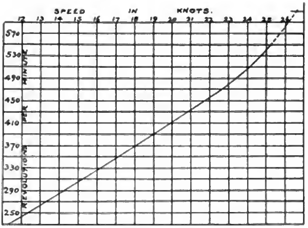
end of the run the displacement would be less than 3,750 tons by a similar amount, and the average displacement in each case figured out very closely to the specified trial figure. In the case of the *Salem* the average was 3,745 tons. In the case of the *Chester*, it was 3,717 tons.



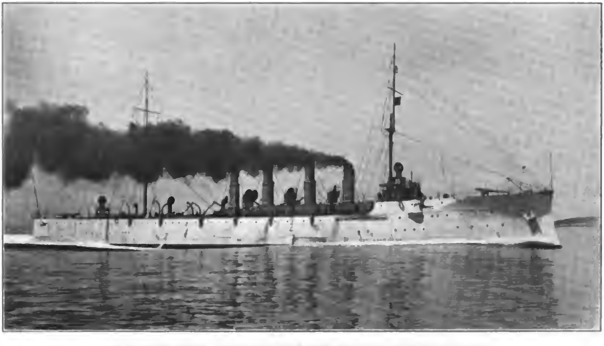
CURVES FROM STANDARDIZATION RUNS OF THE SCOUT CRUISER SALEM.

The *Salem*, built by the Fore River Shipbuilding Company, is propelled by twin screws, actuated by Curtis turbines of the 7-stage type, 120 inches in diameter, the revolutions at full speed being about 375 per minute. These are located in two separate compartments; the port turbine is aft and the starboard turbine forward. Each turbine has an outside diameter of 11½ feet, and a length of 15 feet.

The trials started with standardization runs to determine the number of revolutions of the propellers necessary to give the designed full speed, as well as the other prescribed trial speeds. These were followed by a four-hour full power trial, under which an air pressure of 5 inches was permissible. Two 24-hour endurance runs at 22½ and 12 knots respectively, completed the steam trials. In each case the probable consumption of coal during the runs was computed beforehand, and the displacement of the ship was so adjusted that it would be greater than the designed displacement of 3,750 tons by one-half this amount of coal. Naturally, at the



STANDARDIZATION CURVE OF CHESTER.



THE CURTIS-TURBINE-PROPELLED SCOUT CRUISER SALEM ON OFFICIAL FOUR-HOUR TRIAL TRIP.
(Copyright, 1908, N. L. Stebbins.)

The table gives very clearly the general results of the four sets of trials, and shows the superior economy of both the turbine-propelled ships, as compared with the *Birmingham*. The superiority of the *Birmingham* at full speed is explained by the fact that her full speed was approximately two knots less than that of the other two ships. If we reduce the speeds of the *Salem* and *Chester* to 24.325 knots, on the assumption that the power (and consequently coal consumption per hour) varies as the cube of the speed, we find that the radius of the *Salem* becomes 1,634 nautical miles, and of the *Chester* 1,746 nautical miles, as compared with 1,730 for the *Birmingham*. It will be noted that these figures have been based upon the consumption of 950 tons of coal, instead of either the normal coal supply or the full bunker capacity. This is due to a desire to use the results as shown on trials, and it is possible to do this only by so adjusting matters as to make the average displacement close to 3,750 tons. We have, therefore, assumed that each ship starts such a run with double the normal coal supply, and ends it without any coal.

In addition to the data given in the table and on the diagram, showing standardization results for the *Salem*, we may say that the air pressure during the 4-hour run was only 4 inches of water, in place of the 5 inches allowed. The flue gas temperature averaged 750 degrees F. The brake horsepower, as given by a Foettinger torsion meter, was 19,200, which compares very closely with the 19,015 horsepower given by a Denny-Johnson torsion meter. At 22½ knots speed, the *Salem* used 2 inches air pressure and showed a flue gas temperature of 585 degrees; at 12 knots the air pressure was 1 inch and the flue gas temperature 525 degrees. On this trial only four boilers were used. The high run on the standardization trials was made with 3.8 inches of air pressure, and showed 20,200 brake horsepower, with 382.4 revolutions per minute; the speed was 26.886 knots. The propellers of the *Salem* are three-bladed, with a diameter of 9 feet 6 inches and a pitch of 8 feet 8 inches. The pitch ratio is 0.912; the developed area, 43.7 square feet; the developed area ratio, 0.616; and the projected area, 38.2 square feet.

In the starting and stopping tests, at a speed of about 24¼ knots, the *Salem* was stopped dead in the water and started astern in 2 minutes 48 seconds. From the giving of the signal until the turbines had stopped a period of 42 seconds

SCOUT CRUISER TRIALS.	Birmingham	Salem.	Chester.
Standardization Date	March 11	June 23	Feb. 28
Best uncorrected run, knots	25.192	26.886	26.22
Mean of best pair of runs, knots	24.477	26.11	25.138
Mean of five high runs, knots	24.236	25.957	25.074
R. P. M. required for 24 knots	187.23	335.2	507.26
R. P. M. required for 22.5 knots	170.38	312.	466.4
R. P. M. required for 12 knots	89.7	165.	245.5
Full speed, four hours Date	March 12	June 25	March 1
Mean displacement	3,720.	....	3,673.
Mean speed	24.325	25.947	26.52
Mean R. P. M	191.66	378.39	614.31
Apparent mean slip, percent	15.8	19.8	25.6
Coal per hour, pounds	29,904.	38,502	38,332.
Indicated horsepower	15,540.	21,333 *	....
Admiralty coefficient	222.5	197.5	....
Brake horsepower	....	19,200	Unknown†
Coal per I. H. P. per hour	1.92	1.81*	....
Coal per B. H. P. per hour	....	2.01	?
Miles per ton of coal	1.822	1.51	1.548
Radius (nautical miles) *a*	1,730.	1,434	1,471.
Twenty-four hours at 22.5 knots Date	March 14	June 30	March 3–4
Mean displacement	3,741.	....	3,716
Mean speed	22.665	22.336	22.779
Mean R. P. M	172.1	312.535	473.34
Apparent mean slip, percent	12.6	15.7	18.7
Coal per hour, pounds	20,510.	18,485.	18,063.
Indicated horsepower	10,760	10,378 *	....
Admiralty coefficient	260.9	266.5	....
Brake horsepower	....	9,340	Unknown†
Coal per I. H. P. per hour	1.91	1.78*	....
Coal per B. H. P. per hour	....	1.97	?
Miles per ton of coal	2.475	2.73	2.83
Radius (nautical miles) *a*	2,348.	2,593.	2,086
Twenty-four hours at 12 knots Date	March 13	June 26–27	Feb. 28–29
Mean displacement	3,743.	....	3,710
Mean speed	12.228	11.937	12.2
Mean R. P. M	91.4	164.11	249.7
Apparent mean slip, percent	11.2	15.15	17.5
Coal per hour, pounds	4,629	4,051.	4,091.
Indicated horsepower	1,600	1,511 *	....
Admiralty coefficient	275.2	271.7	....
Brake horsepower	....	1,360.	Unknown†
Coal per I. H. P. per hour	2.89	2.68*	....
Coal per B. H. P. per hour	....	2.98	?
Miles per ton of coal	5.965	6.6	6.66
Radius (nautical miles) *a*	5,643	6,269.	6,338

* Equivalent I. H. P. based on assumption of 10% engine friction.
† Torsion meter gave totally unreliable readings, going as high as 28,000 horse power at full speed.
a Starting with 950 tons of coal

had elapsed, while a further period of 48 seconds was required to bring the turbines up to full speed astern. From full speed of ship astern until the turbines were at rest required 15 seconds; from full speed astern until the turbines were running full speed ahead, the time was 1 minute 4 seconds.

The curve of propulsive efficiency for the *Salem* is particularly interesting, showing a maximum of nearly 63 percent at from 24 to 24½ knots, and a figure of more than 59 percent at 26 knots. Reducing these figures to corresponding amounts for equivalent indicated horsepower we find that the maximum would be about 56½ percent, and the figure at 25 knots about 53½ percent, both being splendid results.

Special features of the trials of the *Chester* follow in tabular form. It may be said that during the 22½ knot trial there was in operation a considerable amount of auxiliary machinery, including the evaporating and distilling plant, icemaking plant, ash hoists (as required), complete ventilating and steam heating systems, and all auxiliaries required in operating machinery. The astern trials on March 4 were made under a steam pressure of 105 pounds per square inch, the revolutions per minute being 390, and the speed astern 12 knots.

TWENTY-FOUR-HOUR ENDURANCE TRIAL AT 12 KNOTS, FEBRUARY 28 AND 29, 1908.

Average Pressure, Pounds per Square Inch Gage.	Forward Engine Room.	After Engine Room.
Main steam	155. lbs.	147.4 lbs.
High-pressure turbine	10.3 lbs.	8.2 lbs.
Low-pressure turbine, vacuum	23.41 ins.	23.4 ins.
H. P. cruising turbine	83.2 lbs.	.....
I. P. cruising turbine	20.9 lbs.	.....
Mercury gage (condenser vacuum)	29.0 ins.	28.8 ins.

Barometer at start of trial	29.75 ins.
Four boilers only used—grate surface	232 sq. ft.
With natural draft, coal consumption per sq. ft. of grate surface	17.7 lbs.

TWENTY-FOUR-HOUR ENDURANCE TRIAL AT 22½ KNOTS, MARCH 3 AND 4, 1908.

Average Pressure, Pounds per Square Inch Gage.	Forward Engine Room.	After Engine Room.
Main steam	230 lbs.	230 lbs.
High-pressure turbine	98 lbs.	93 lbs.
Low-pressure turbine	0 lbs.	2.25 ins.
H. P. cruising turbine, vacuum	10 ins.	.....
I. P. cruising turbine	180 lbs.	.....
Mercury gage (condenser vacuum)	29.9 ins.	29.3 ins.
Second expansion, H. P. turbine	53 lbs.	50 lbs.
Auxiliary exhaust	....	2 lbs.

Temperature of feed heater outlet	185° F.	204° F.
Main injection	35° F.	
Outboard delivery	64° F.	
Coal per sq. ft. of grate surface per hour	26 lbs.	
Air pressure	0.7 inch.	

FOUR-HOUR FULL SPEED TRIAL, MARCH 1, 1908.

Auxiliary exhaust	16 lbs.
Temperature of feed heater outlet, mean	217.5° F.
Outboard delivery	75° F.
Main injection	34° F.
Coal per sq. ft. of grate surface per hour	55 lbs.
Air pressure—Maximum	3 ins.
Average	2.75 ins.
Highest speed for 15 minutes	26.6 knots.

Average Pressure, Pounds per Square Inch Gage.	Forward Engine Room.	After Engine Room.
Main steam	243.5 lbs.	246.7 lbs.
High-pressure turbine	238.7 lbs.	239.5 lbs.
Low-pressure turbine	15.5 lbs.	15 lbs.
Mercury gage (condenser vacuum)	28.8 ins.	28.3 ins.
Second expansion, H. P. turbine	159.5 lbs.	149.8 lbs.
H. P. cruising turbine, vacuum	20 ins.	.....
I. P. cruising turbine, vacuum	20 ins.	.....
Astern turbine	28 ins.	28 ins.

In the full-power trial of the *Birmingham* the air pressure was kept at 2¾ inches, the steam pressure at the engines was 225 pounds per square inch, and the vacuum averaged 26.4 inches. During the 24-hour trial at 22½ knots, these figures were, respectively, 1.08 inches, 174½ pounds, and 27.1 inches. The 12-knot trial gave corresponding results of ¼ inch, 151½ pounds, and 26.8 inches.

The success attending the trials was anticipated by the naval constructors in the demonstration of the design three years ago in the model basin at the Washington navy yard. It was there found that a vessel of 4,000 tons displacement and 350 feet long required, in order to make 26 knots, more than double the horsepower of a vessel of the same displacement, but made narrower and shallower, and stretched to 450 feet in length.

A feature which impressed the observers on board the *Birmingham* and *Chester* was the advantage obtained by the *Chester* in lack of vibration, a characteristic which contributes to the steadiness of the vessel as a gun platform. In the case of the *Birmingham*, the vibration from the reciprocating engines was at times positively unpleasant, especially when the ship was running at high speed, and was particularly noticeable in the cabins even when the vessel was at 22.5 knots, while on the *Chester* there was hardly any perceptible vibration. The advocates of the turbine have extracted much comfort from this practical demonstration, and are more than ever confident that the day of the reciprocating engine for large ships of war has virtually passed.

MARINE ENGINE DESIGN.

BY EDWARD M. BRAGG, S. B.

RECIPROCATING MEMBERS.

The reciprocating parts of a marine engine are usually designed for the maximum load to which the parts will be subjected. This load cannot be determined before the engine is built, as it depends largely upon the valve setting, and the indicator card is needed in order that the steam load may be determined. The maximum load can be determined approximately, however, by means of factors obtained from the analysis of the results of engine trials. If *I. H. P.* is the indicated horsepower developed in a cylinder with a piston speed per minute = *P. S.*, then the mean total load acting upon the piston

$$= \frac{I.H.P. \times 33{,}000}{P.S.}.$$

It has been found in the results analyzed that the maximum load was about 1.93 of this mean theoretical load. The formula to be used here for finding the maximum load for which the reciprocating parts are to be designed is, therefore,

$$W = \frac{2 \times I.H.P. \times 33{,}000}{P.S.}, \qquad (20)$$

where *I. H. P.* is the indicated horsepower to be developed in the cylinder in question. It will be found that this gives

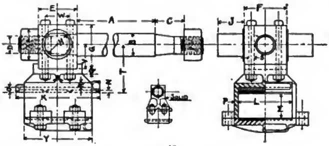


FIG. 17.

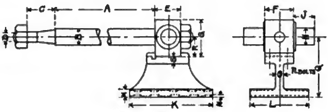


FIG. 18.

PISTON ROD, CROSSHEAD AND BOX GUIDE.

A	B	C	D	E	F	G	H	J	K	L	M
3' 2"	3 1/2"	.....	3"	7"	7 1/2"	7"	4 1/2"	5 1/2"	14"	9"	.....
3' 7"	3 1/2"	5 1/2"	3"	7"	8"	8"	4 1/2"	4 3/4"	15 1/2"	10"	4 1/2"
4' 0 5/8"	3 1/2"	5 1/2"	3 3/4"	7"	7"	8"	4 1/2"	4 5/8"	17"	8"	4 1/2"
3' 11 1/2"	4 1/2"	7 1/2"	3 1/2"	8"	8"	8 1/2"	4 1/2"	5 1/8"	18"	11"	5"
.....	5"	.....	3 3/4"	9 1/2"	9 1/2"	9 1/2"	6"	6 1/2"	21"	12 3/4"	6 1/2"
4' 10"	6 1/2"	7 1/2"	5 1/2"	10"	10"	10"	7 1/2"	7 1/2"	22"	16"	6 1/2"
4' 6"	4 7/8"	7 1/2"	3 3/4"	8 1/2"	8"	8"	5 1/2"	6 1/2"	17 1/2"	12"	4 3/4"
2' 10"	2 1/2"	4"	2"	5"	5"	5"	3 1/2"	4"	10"	7"	3"

N	O	P	Q	R	S	T	U	V	W	X	Y
7/16"	1 1/4"	.....	.....	1/2"	1 1/8"	.....	.....	.....	.....	.....	.....
3/8"	7/8"	1/2"	1/2"	1/2"	1"	8 1/2"	3/4"	4 1/2"	4 1/2"	5 1/2"	12 1/2"
1/2"	1"	3/4"	1"	7/8"	1"	4 1/2"	3/4"	4 1/2"	4 1/4"	5 3/4"	14"
1/2"	1 1/8"	7/8"	1"	15/16"	1 1/8"	10"	7/8"	4 1/2"	5"	6 1/8"	13"
1/2"	1 1/4"	1 1/4"	1 1/8"	.....	1 1/4"	14 1/2"	1/2"	4 1/2"	5 1/2"	.....	21"
7/8"	1 1/2"	1"	Solid	1"	.....	14 1/4"	1 1/2"	.....	.....	.....	22"
1/2"	.....	.....	Solid	.....	1 1/8"	12 1/2"	.....	.....	.....	6 1/2"	13"
.....	3/4"	3/8"	Solid	1"	3/4"	7"	1 1/4"	.....	.....	.....	8"

PISTON ROD, CROSSHEAD AND SINGLE SLIPPER GUIDE.

A	B	C	D	E	F	G	H	J
4' 7 1/2"	5"	.....	4 1/2"	9"	9 1/2"	9"	6"	7"
5' 6 1/2"	5 3/4"	.....	4 3/4"	10 1/2"	11"	11"	7 1/2"	8 1/2"
5' 0 1/2"	5 3/4"	.....	5"	11"	10 1/2"	10 1/2"	7 1/4"	8 1/2"
5' 5 5/8"	7"	9"	5 1/2"	12"	13"	12"	7 1/2"	9"
7' 7"	7 1/2"	.....	5 1/4"	13 1/2"	12 3/4"	13 1/2"	9 1/2"	10"
5' 8 13/16"	7 1/2"	.....	6 1/2"	14"	14"	14"	10 1/2"	11 1/2"
9' 2 1/2"	8 1/2"	.....	5"	16"	17"	18 1/2"	11"	13 1/2"
5' 3/16"	8 1/8"	10"	6 1/2"	14 1/2"	15"	14"	9"	11"
4' 0 3/8"	4 1/2"	4 1/2"	3 3/4"	7"	7 1/2"	8 1/2"	5"	8 3/8"

K	L	M	N	O	P	Q	R	S
21"	12 1/2"	2 1/2"	7/16"	3 1/4"	4' 1 1/2"	.....	.....	.....
27"	13 1/2"	2 3/4"	1/2"	3"	4' 1 5/8"	.....	.....	.....
24"	16"	3"	1/2"	3"	4' 1 5/8"	.....	.....	.....
23 1/2"	19"	2 1/2"	1/2"	2 3/4"	6' 1 1/4"	17 1/2"	6 1/2"	1 1/2"
30"	22 1/2"	3 1/4"	1/2"	3"	4' 1 3/4"	.....	.....	.....
30"	26"	3 1/2"	1/2"	3 1/2"	4' 2"	.....	.....	.....
44"	28 1/2"	3 3/4"	1/2"	4"	4' 2 1/2"	26"	10"	2 1/2"
26"	24"	3"	1/2"	3 1/4"	4' 2"	19 1/2"	7"	1 1/2"
16"	14"	1 3/4"	7/16"	1 1/4"	2' 1 1/2"	12 3/4"	5"	1 1/2"

very nearly the same results as the formula often used, $W =$ area $\times$ boiler pressure.

Piston Rods.—Piston rods are usually of the shape shown in Figs. 17, 18, 19 and 20, with a parallel middle body subjected to alternating loads, shouldered at each end of the parallel body to take the thrust, and threaded portions beyond to take the tension, the latter portions being subjected to intermittent loads. A column formula must be used for the design of the middle portion, and in these calculations a formula based upon Rankine's long column formula will be used.

The formulæ for solid and hollow rods are as follows:

Solid rods, $$D^2 = \sqrt{\frac{0.48FCl^2}{10{,}000{,}000} + F^2} + F; \qquad (21)$$

Hollow rods, $$D^2 = \sqrt{\frac{0.48FCl^2}{10{,}000{,}000} + F^2 + (2F + d^2)d^2} + F; \qquad (22)$$

where D = the diameter of the rod in inches at the middle of its length;

$F = \dfrac{2W}{\pi f}$;

W = load on rod (Formula 20);

f = allowable stress per square inch $= \dfrac{C}{N}$;

C = the ultimate strength of the material,

= 60,000 to 70,000 pounds for merchant work,

= 80,000 to 100,000 pounds for naval work;

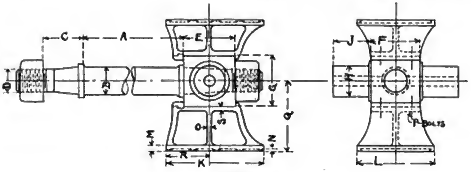


FIG. 19.

PISTON ROD, CROSSHEAD AND DOUBLE SLIPPER GUIDE.

A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	S
5' 2"	6 3/4"	9"	5 1/4"	11 1/2"	10 3/4"	11 1/2"	7"	8 1/2"	22"	17"	1 1/2"	1/2"	1"	4' 1 1/2"	14"	10"	1 1/2"
.....	4"	.....	.....	9 3/4"	10"	9 1/2"	5"	6 1/2"	19"	12"	1 1/2"	1/2"	1/2"	.....	12"	9 1/2"	1 1/4"
5' 5 3/4"	6 1/2"	.....	5 1/2"	10"	11"	10"	6 1/2"	7 3/4"	24"	12"	1 1/2"	1/2"	1"	4' 1 1/2"	.....	.....	.....

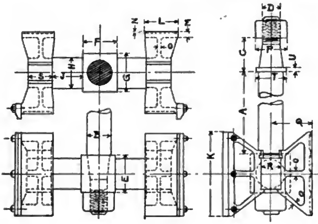


FIG. 20.

PISTON ROD, CROSSHEAD AND FOUR SLIPPER GUIDE.

A		B	C	D	E	F	G	H	J	K
8'	8¼"	8"	11½"	6"	13"	11½"	13"	10½"	10"	28"
9'	6"	11"	13"	8¾"	16½"	15¾"	16¾"	13¾"	16½"	47"

L	M	N	O	P	Q	R	S	T	U
11"	2"	.....	1"	10½"	14"	7"	8"	10"	1½"
20"	2¾"	¾"	1"	13¾"	17¾"	8½"	14"	12"	1¼"

N = factor of safety = 8 to 10 for torpedo boat engines,
= 12 to 14 for other naval engines,
= 15 for merchant ship engines;

l = length of rod in inches from under side of piston to upper side of crosshead block = (approximately) stroke + diameter of high-pressure cylinder + X, where X = 2 to 8 inches for merchant ship engines, = − 2 to − 8 inches for naval engines;

d = inside diameter of hollow rod, and may be taken from $\frac{1}{3}\sqrt{2F}$ to $\frac{2}{3}\sqrt{2F}$.

In discussing the factors of safety to be used for different kinds of loads, it was stated that 12 would be used for alternating loads. It was also stated that these factors would be modified sometimes by reason of the conditions under which the part worked. The piston rod is guided more or less rigidly at three points: at the piston by the piston rings, at the stuffing-box, and at the cross-head. These three points may be out of line in the first place, or may get out of line as the engine works, and thus cause the rod to have an initial flexure at times. The factor 0.48 in the formula assumes that the rod is held rigidly at the cross-head end, and that only two-thirds of its length is subjected to bending, whereas it is probable that it is not held rigidly at the cross-head. A third reason for modifying the factor is that the rod is working a part of the time in steam and part in the open air, and runs through a stuffing-box, which may get hot and grip it. When all of these conditions are considered it seems wise to increase the factor of safety from 12 to 15 for this member.

The thrust of the rod is transmitted to the piston and cross-head block by means of a shoulder, either positive, as in Figs. 19 and 20, or negative, as in Figs. 17 and 18. This shoulder, when negative, has a breadth of 1/16 inch in the smallest rods and 3/16 in the largest rods. When the shoulder is positive it is generally broader, varying from ¼ inch to ½ inch. The threaded portion of the rod, having to transmit tension only, is designed to have sufficient area at the root of the threads to transmit the load with a factor of safety of 10. As four threads per inch are generally used, the diameter of this portion must be increased by

$$\frac{1.299}{4} = 0.325 \text{ inch (about)},$$

to allow for cutting the threads. The diameter of the threaded portion, taken to the nearest ¼ inch, should be:

$$D' = \sqrt{\frac{40W}{\pi C}} + 0.325. \qquad (23)$$

(W and C are as above.)

The connection between the shoulder and the threaded portion is usually made by means of a tapered part, the taper being 2 or 3 inches per foot. Cylindrical nuts are generally used in attaching the piston and the cross-head.

The length of the rod between shoulders will be given only approximately by the formula L = stroke + high-pressure diameter + X. This is near enough for calculation, but the final length should be determined from the assembly drawing.

Bearing Pressures.—Before proceeding further with the design of the reciprocating parts, it will be well to take up the question of pressures allowed upon bearing surfaces. It is usual to figure the bearing surface of pins and shafts as equal to the length of the surface multiplied by the diameter of the pin or shaft, *i. e.*, as equal to the *projected* area of the bearing. The pressure allowed must be low enough to keep the bearing cool, and varies with the conditions and the possibility of artificial cooling. When there is no motion between two parts the pressure between them can be very large, but as the extent of the motion between them increases the pressure allowed decreases. Since it is a question of keeping the bearing cool, we can deal with the mean unit bearing pressure, since the maximum will occur generally but for an instant. In some cases, however, it is more convenient to deal with the maximum pressure to avoid confusion. The pressures allowed upon the different surfaces are shown in Table VII. The

TABLE VII.

Allowable pressure on bearing surfaces in pounds per square inch of projected surface:

	Merchant.	Naval.
USING MEAN LOADS—		
Crank Pin	200 to 250	250 to 300
Main Bearings	200 to 350	250 to 500
USING MAXIMUM LOADS—		
Slipper Guide	60 to 80	70 to 100
Crosshead Pins	850 to 1,200	1,200 to 1,800
Link Block Pin	750 to 1,000	850 to 1,200
Link Block Gibs	250 to 400	350 to 500
Eccentric Rod Pins	700 to 950	900 to 1,100
Drag Rod Pins	500 to 700	700 to 800
Eccentrics	150 to 200	175 to 225
Thrust Collars	50 to 80	80 to 100

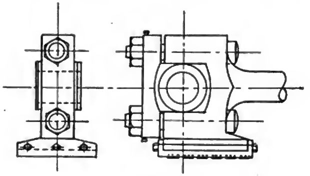


FIG. 21.

most of the pressures are based upon the maximum loads, as these loads are used in the design of the other parts, and it is less confusing to deal with but one load. It will be noticed that those surfaces which have but little relative motion have the greatest unit pressure allowed upon them, while those with more motion, such as the slipper, main bearings and crank pins, have a lower unit pressure allowed. The question of the determination of the loads coming upon the different surfaces will be taken up later.

Cross-Head Block.—There are two types of cross-heads, those with external bearing surface, as shown in Figs. 17, 18, 19 and 20, and those with internal bearing surface, as shown in Fig. 21. When the bearing surface is external, the block is approximately a cube, with the two cross-head pins projecting from two opposite faces. When the bearing surface is internal, the cross-head consists of a box, with bottom brass and cap, in which works a pin held fast in the jaws of the connecting rod fork. (See Fig. 22.) This latter type is used principally upon small, fast running engines, and upon torpedo boat engines.

The cross-head block with external bearing surface is generally from 1.8 D to 1.9 D upon a side (D being the diameter of the piston rod), and tends to split upon a plane passing through the axis of the piston rod, where the cross-section of metal resisting the bending moment is shaped as shown in Fig. 23. The bending moment upon this section will be

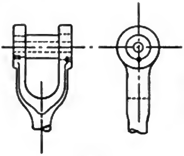


FIG. 22.

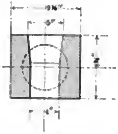


FIG. 23.

$$M = \frac{WL}{4},$$

where W is the load previously found, and L is the distance from center to center of cross-head pins.

Cross-Head Pins.—The maximum load W, divided by P, the allowable pressure upon the cross-head pins, taken from Table VII., will give the surface that must be provided in these pins, or

$$l \times d = \frac{W}{2P},$$

where l = the length of one pin and d = its diameter. The diameter d should be from 1.2 D to 1.4 D, where D is the diameter of the piston rod. This will give a pin with a sufficiently strong attachment to the block, so that no other calculation need be made upon it. This diameter of pin may have to be changed later on, when the dimensions of the upper end of the connecting rod are known, but it is sufficiently close for calculation. The length of the pin will usually come about equal to its diameter.

The breadth of the block having been assumed, and the length of the pins found, the bending moment $\frac{WL}{4}$ can be found.

The moment of inertia of the section resisting the bending is

$$I = \frac{bh^3}{12},$$

where b is the net breadth after taking out the piston rod hole, and h is to be found so that the stress shall be reasonable.

$$h = \sqrt{\frac{3WL}{2bf}}. \qquad (24)$$

Here f should be chosen so that the factor of safety will be 12. The cross-head blocks are usually made of wrought steel, or cast steel, with the pins hardened. A facing strip should be allowed around each pin, from 1 inch to 2 inches wide, and projecting from the block 1/16 to ⅛ inch.

If the cross-head has internal bearing surface, the length and diameter of the bearing are calculated in the same way as are the pins,

$$l \times d = \frac{W}{L}.$$

The length of the pin determines the thickness of the block, and the other details are figured in the same way as are the boxes of the connecting rod, whose design will be taken up later.

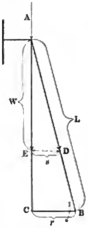


FIG. 24.

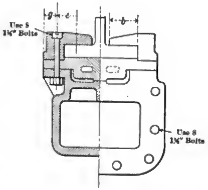


FIG. 25.

Slipper.—The slippers attached to the cross-heads are usually one of the four types shown in Figs. 17, 18, 19 and 20. Fig. 17 shows the type used upon many small engines of 1,000 indicated horsepower and less. It is a cast-steel box, inclosing for a guide a square cast-iron beam, upon whose front and back surface the slipper bears. There are some parts of the slipper which should be figured, such as the amount of surface and sizes of bolts, but there are other parts which are determined by practical considerations, and dimensions such as P, R, O, Q, U, etc. (see table accompanying Fig. 17), can be taken from blue prints of other engines, or from the figures here given.

The dimensions K and L of the bearing surface are determined from the total load coming upon the guide and the allowable unit pressure given by Table VII. The maximum pressure comes upon the slipper when the crank is 90 degrees from the line of dead points. Referring to Fig. 24, it will be seen that when a load $W = A\ E$ acts through the piston rod $A\ A$, and is transmitted to the connecting rod $A\ B$, a load $E\ D$ will come upon the slipper. This load

$$S = W \times \frac{ED}{AE},$$

or, approximately,

$$G = W \times \frac{ED}{AD} = W\frac{r}{l},$$

where $\frac{r}{l}$ is the ratio of the crank length to the length of the connecting rod. This ratio usually is from ¼ to 1/5 for marine engines. The amount of surface for the slipper will then be

$$K \times L = \frac{W \times r}{l \times P}. \tag{25}$$

The tables under Figs. 17, 18, 19 and 20 will show that K and L are nearly equal in smaller engines, but that $K = 1.5\ L$ in the larger engines. The bolts joining the slipper to the cross-head, and those joining the two parts of the box, must be figured for the load G. The distance from the center line of the piston rod to the surface of the slipper, see Q, Figs. 17 to 20, must be sufficient to have the boxes on the forked end of the connecting rod clear any adjacent parts or surfaces when angled over the extreme amount. The exact distance must be taken from the assembly drawing, but it will generally be from 2.5 D to 3 D.

The cast-iron beam upon which the box guide slides can be figured as a beam supported at the ends, and loaded at the middle with a load G. Its length will equal the stroke of the engine + K. The thickness of the beam M can be assumed from the table, and the beam figured as though of solid cross-section, although it will be cored out inside to permit water to circulate and carry off the heat.

The type of slipper shown in Fig. 18 is the one most commonly used. The amount of surface needed when going ahead is figured in the same way as in the previous case, but as the "backing" surface is upon the back of the slipper, it will be less than the "go-ahead" surface, because of the web joining the slipper to the block flange. The "backing" surface is made as great as possible, but is usually only about two-thirds of the "go-ahead" surface. When backing, there is a tendency for the slipper to break close to the web spoken of, so that it must be figured for bending at that point.

The arrangement of slipper and backing guide is shown in Fig. 25. It is assumed that all of the restraining pressure exerted by one backing guide $= \frac{G}{2}$, is acting at the center of the surface, with an arm $\frac{b}{2}$. The front and back of the slippers are recessed to take white metal, so that the thickness effective for resisting bending will be that between the backs of the white metal. Choosing a stress appropriate for the material of which the slipper is to be made, generally cast or wrought steel, the necessary thickness of slipper between the backs of the white metal will be

$$t = \sqrt{\frac{W \times r \times b \times 6}{2 \times l \times 2 \times K \times f}}, \tag{26}$$

where W = load upon piston rod,
r = length of crank,
b = breadth of backing surface in one guide,
l = length of connecting rod,
K = length of slipper,
f = a stress which will allow a factor of safety of 12, since the slipper is subjected to loads acting in opposite directions.

The thickness thus found must be increased by the thickness of white metal on each face.

The backing guide can be figured in the same way, by merely changing the allowable stress, as cast iron is usually employed for the backing guide, and it is assumed that only that portion of the guide in immediate contact with the slipper resists the bending; therefore, K has the same value as before. Since the bending takes place where there is a sharp corner, it is well to use a low stress, about 1,500 pounds for cast iron. The bolts attaching the backing guide to the engine frame are spaced from 6 to 8 diameters apart. These bolts are brought into play only when the engine is backing, and it will be assumed that all of the bolts in the guide help to carry the load. This load will be

$$\frac{G}{2} \times \frac{e + g}{g} \text{ (see Figure 25)},$$

the distance $e + g$ depending upon the size of bolt used, and this size will have to be determined by trial. The number of bolts will be

$$\frac{K + s}{n},$$

where K = length of slipper, s = length of stroke, and n = spacing of bolts. These bolts can be placed within a half inch of the edge of the slipper. Therefore,

$$e = \frac{b}{2} + \frac{1''}{2} + \frac{d}{2},$$

where d = diameter of bolt assumed. The bolt should be placed not nearer to the outer edge of the guide than 1.5 d, and the projecting lip will be from ½ inch in small engines to 1 inch in larger engines, so that g = 1.5 d + ½ inch to 1 inch. The effect of placing the bolts so far to one side of the line of action of the force will be to increase the effective load $\frac{G}{2}$ to about G, and this can be kept in mind when selecting the trial size of bolt from Table IV.

When the cross-head block is provided with two slippers, as shown in Fig. 19, there is as much "backing" surface as "go-ahead" surface, and a guide must be provided for both sides of the engine frame. In this case the back of the slipper does not have to be kept open to clear the "backing" guide, so additional webs can be put in, thus making a much stronger and stiffer slipper. Since the slippers are not subjected to bending, they can be made thinner than in the previous case; and the webs, joining the slipper to the flange which connects it to the block, are made thinner than the single web. These thicknesses cannot be figured, but are determined by practical considerations; the parts must be thick enough to "look well," and have the requisite stiffness. The data given with Fig. 19 will be useful in this respect.

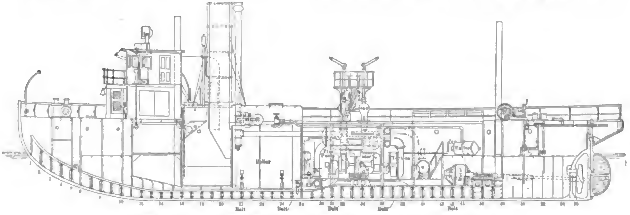
The cross-head shown in Fig. 20 is used on very large engines. The "backing" surface is equal to the "ahead" surface, and all of the parts are designed in the same way as those previously mentioned. This design enables the columns to be placed closer to the center line of the engine, and is used generally with four cast-steel columns to each cylinder, upon each of which is a guide surface.

Upon all of the types of cross-heads it will be noticed that provision is made for removing the slipper without disturbing the alinement of the other parts. The key at the top of the block, which permits this removal, is held in place by two or more bolts. In the "two-slipper" and "four-slipper" type of guide, the bolts attaching the slipper to the block need be only ¾ inch to 1 inch in diameter. In the other types they should be figured to carry the full load coming upon the slipper when backing. The key at one end and the lip at the other prevent any shear from coming upon these bolts.

(To be continued.)

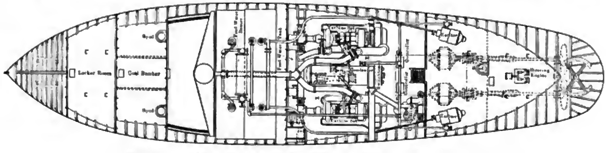
CHICAGO FIRE BOATS.

Designed by W. I. Babcock, New York, two fireboats for the fire department of the city of Chicago have been built by the Manitowoc Dry Dock Company, Manitowoc, Wis., and were expected to be fully completed and go into service by the middle of this summer. For facility in maneuvering in the narrow and crooked river, and in the slips where the boats have to work, they are fitted with twin screws, and also with steam steering gear. By working one screw ahead and the other astern the boats can be swung completely around as on a pivot in either direction.



INBOARD PROFILE OF THE CHICAGO FIRE BOATS, SHOWING LOCATION OF PUMPS AND FIRE NOZZLES.

Hulls.—The boats are 120 feet over all, 109 feet 6 inches between perpendiculars, 28 feet molded beam, 15 feet molded depth, and will have a draft of about 9 feet 6 inches. They are constructed of steel throughout, practically no wood being used anywhere except for the inside finish of the deckhouse and pilothouse. The fore foot is cut away considerably, both for convenience in handling and for breaking ice, and the bows at the waterline are heavily strengthened also for the latter purpose. There are five bulkheads, of which four are watertight, and lower decks forward and aft, dividing the hull into six watertight compartments.



GENERAL ARRANGEMENT OF PUMPING AND PROPELLING MACHINERY ON THE CHICAGO FIRE BOATS.

With the exception of the engine-room skylight, the low boiler trunk and a deckhouse immediately forward of it containing a toilet and a large hose room, with pilot house on top, the deck is flush. A plate bulwark forward continues back to the deckhouse, from which an open iron rail extends aft, supported by cast steel stanchions. Two lines of heavy iron trough-shaped fenders run all fore and aft on the outside of the hull.

Machinery.—The arrangement of the machinery is novel, in that the same engines are used for operating the fire pumps and for propelling the vessel, thus entirely doing away with separate propelling engines. Each boat is fitted with two centrifugal fire pumps, built by the I. P. Morris Company, of Philadelphia, of the two-stage type, with 14-inch suction and discharge, and capable of delivering together 9,000 gallons of water per minute at a pressure of 150 pounds per square inch, when running at a speed of 1,700 revolutions per minute. By branch pipes, properly fitted, the discharge of one pump can be turned into the suction of the other, thereby running the pumps in tandem as one four-stage pump, then delivering 4,500 gallons per minute at 300 pounds pressure. This, going through a 3½-inch nozzle, will make a tremendously powerful and effective stream.

At 125 pounds pressure these pumps will each develop 5,500 gallons per minute. One of the great advantages of the centrifugal pump for this service is that the volume and capacity can be varied at will. Combined with this is a smoothness of operation and lack of necessity for attention not found in any other pump, while if inadvertently all discharge openings are closed at once the pressure would rise but slightly, and there would be no danger of bursting hose or anything else.

Another great advantage of centrifugal pumps operated by steam turbines lies in the fact that the boat can throw her rated capacity of water at all times, and there is a great saving of fuel over the ordinary reciprocating pumps operated with single non-condensing steam cylinders. The water consumption of the turbine per horsepower per hour is only about 17 pounds, while with the reciprocating pump it is probably three times that amount. It is practically impossible to put boilers enough in the boat to supply this amount of steam. Even with the exhaust turned into the stack to force the draft, which means a low efficiency for the boilers, there is probably no fireboat in service to-day, with reciprocating pumps, that can run those pumps to anywhere near their full capacity. A boat rated as of 9,000 gallons capacity per minute is really only about a 6,000-gallon boat.

The pumps are set one on each side of the ship, drawing from a 14-inch header, extending across the engine room immediately forward of them, and delivering to turrets on deck directly above. All connections are short and direct, and all

curves of easy sweep. The deck turrets are set diagonally on deck, and each has nine 3½-inch openings for hose, with quick-moving lever valves at a convenient height. In winter these turrets will be inclosed in iron casings, to which steam pipes are led, to prevent freezing. At a height of about 7 feet above the turrets is an oval platform carrying the two 3½-inch Universal monitors, which are vertically over the turrets and supplied by 5-inch pipes from them. The supports for the platform and the ladder to it come between the turrets, so as not to interfere with the hose lines. There are no other monitors on the boats, Fire Marshal Horan, of Chicago, believing that smaller ones forward and aft are unnecessary.

Each pump is driven by a horizontal Curtis turbine of 660 horsepower, built by the General Electric Company, of Schenectady, N. Y., and directly connected to it on the same shaft and bed-plate. This shaft also carries a 200-kilowatt generator of the direct-current type, shunt wound for 275 volts, for operating the propelling motors. On each of the propeller shafts of the vessel is placed a direct-current, variable speed, reversing motor, shunt wound, and designed for operating on the variable voltage system, developing 250 horsepower at 200 revolutions per minute.

Two turbo-generator exciting and lighting sets of 25 kilowatts capacity each are provided, either of which alone is sufficient. All generators and motors are to be tested by a stream of water from a hose, and must operate perfectly under such conditions. Steam or moisture in the engine room will therefore have no effect on them.

The generators and motors are supplied with independent controllers, two in the engine room and two in the pilot house, with suitable switching devices, so that only one set can be in use at a time. A switchboard is installed in the engine room. Between the two turbine sets, high up under the deck beams, to save floor space, is a surface condenser built by the Alberger Condenser Company, of New York, with wet and dry vacuum pumps directly beneath it. The 10-inch centrifugal circulating pump is on the port side abaft the turbine set. The capacity of this pump is 3,000 gallons per minute, and it is fitted with a bilge suction, so that it can be used for pumping out the engine room in case of necessity. Feed and pony pumps, sanitary pump, etc., are placed on the bulkhead next the boiler room.

Boilers.—There are two Scotch boilers, built by Johnston Brothers, Ferrysburg, Mich., in a compartment next forward of the engine room, placed side by side, facing forward. These boilers are 12 feet 6 inches in diameter, and 11 feet 6 inches long between heads, built for a working pressure of 170 pounds per square inch. In each boiler are two Morison suspension furnaces, 44 inches diameter, with separate combustion chambers. The boilers have one stack in common, and are operated on the closed stokehold system, with blower in engine room.

Operation.—In the operation of these boats, great speed is not required, and therefore the generators and propelling motors are only of moderate power, less than one-half the capacity of the two turbines. The Chicago river is crossed by bridges every block or two, which must be opened for the passage of the boats, so that high speed is out of the question. It was considered, further, that a combination of circumstances requiring full power on the fire pumps and full power on the propelling motors at the same time for any protracted period is practically impossible, and that if, while the boat is pumping water to her full capacity, the motors are called into service to change her position slightly, the turbines will easily stand the temporary overload.

It was for this reason that the electric propulsion was decided upon. The turbines were there, anyway, for the fire pumps. If ordinary steam engines were used for propelling the boat, it meant two more engines, with four cylinders, valves, shafts, rods and all the complication and working parts to take care of and keep in repair. Adding the generators and motors, which practically require no attention at all, added nothing to the work of the engineer, while by the system of control adopted, he is even relieved of the necessity of answering bells and operating engines as usual. All this is done from the pilot house, where the captain has a lever under each hand, and can control his twin screws, going ahead or back on either or both at any speed instantaneously and entirely independently of the engineer, to whom it makes no difference whether the motors are turning or not.

When the boat is lying at her station, under banked fires, waiting for an alarm, the sea cocks are closed and the pumps drained of water. When an alarm comes in the engineer has only to start his turbines, circulating and air pumps. The captain starts the propelling motors, and, on the run to the fire, the power of the turbines is used for running the boat only, the impellers of the fire pumps turning freely in the casings and doing no work. Special arrangements are fitted for oiling the bearings under this condition. On arrival at the fire, all the engineer has to do is, without stopping the turbines, to open the sea cocks and turn water into the pumps. As soon as the propelling motors stop the generators cease to develop power, and the armatures turn freely, the power of the turbines then being used for pumping only. If the motors are called upon temporarily to shift the position of the boat, the action of the pumps is not interfered with.

When the fire is over and the boat relieved, the engineer simply shuts his sea cocks, opens the drains on the pumps, and the boat goes back to her station.

There are important incidental advantages in driving the screws by motors instead of steam engines. One is that if the boat ever has to go into rough water, there is no racing of the screws, the speed of revolution being constant for whatever voltage is being used; this being governed by the controller. It is also possible for short periods to considerably increase the revolutions and power developed by the motors, though this cannot be done for any length of time, on account of undue heating. Another advantage is that, if a sudden strain is put upon the shaft by the propeller striking heavy ice, or running against dock piles or other obstructions which are frequently encountered in the confined spaces in which the boats must work, the circuit breaker throws out, instantly taking off the power, and there is much less danger of breaking wheels or shafts than if a steam engine were used.

The engineer has to answer no bells at any time, and can devote his whole attention to his machinery. Of this the turbines and fire pumps are entirely inclosed, and require no attention at all, while nothing is more reliable or requires less attention than high-class generators and motors. As an additional precaution the extra controllers are fitted in the engine room, and the engineer can operate the motors on signal from the pilothouse as usual if desired.

A full installation of electric lights is fitted, operated by either one of the turbine exciting sets, and a powerful searchlight is fitted on top of the pilothouse.

The Chicago river is in many places 200 or more feet wide, and the buildings extend right to the water's edge. The depth is about 20 feet. Since the opening of the drainage canal to the Mississippi there is at all times a considerable current in portions of the river. In order, therefore, to hold the boats in a position where they can do effective work on a fire at the river bank, where lines cannot be made fast to moor them, they are fitted with spuds like a dredge, two forward and one aft, working through wells in the bottom of the boat and raised and lowered by steam power. These spuds are made of double thick steel pipe, 18 inches diameter, stiffened internally by heavy plates and angles, shod with cast steel points to take hold of the river bottom, and made watertight to reduce the apparent weight to be handled.

Breakdowns.—These boats are exceptionally guarded against total disablement by breakdowns of any single part of the equipment. Nearly everything is in duplicate. There are two boilers, two fire pumps, two turbines, two generators, two screws, two propelling motors, two exciting and lighting sets, two feed pumps and two injectors. While there is naturally only one condenser, circulating and air pump, the turbines are fitted with disabling pipes, through which they can be exhausted to the atmosphere if necessary, so that any accident which puts the condenser temporarily out of service can only reduce somewhat the efficiency of the boat without causing her to be laid up entirely.

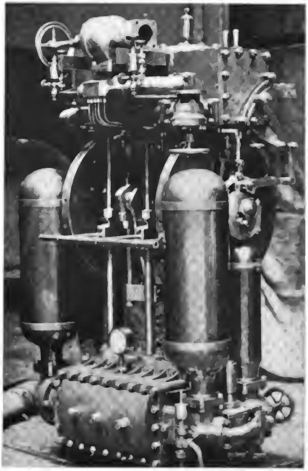
The Float Beta of the London Fire Brigade.

The powerful steam fire pumps and other fire-fighting apparatus on board the *Beta*, the latest and most powerful fire float on the Thames, have been specially designed and constructed by Shand, Mason & Co., of Blackfriars, London. The *Beta* marks fifty years of the Thames floating steam fire engine, and the contractors for the initial steam fire float (Shand & Mason) were the predecessors of the present firm.

The fire-extinguishing output of the *Beta* is furnished by four pumping engines, each of which will deliver 1,000 gallons per minute at a pressure of 140 pounds to the square inch. These engines are so arranged that each can be worked separately, or two, three or four together. The pumping capacity of the float in the latter case is 4,000 gallons per minute or, roughly speaking, 900 tons of water per hour.

The pumping engines are of Shand, Mason & Co.'s patent double vertical type, giving a uniform delivery of water under even pressure, and are fitted with their variable steam expansion arrangement, this providing the greatest power possible with a given supply of steam. It may be noted that the latest land steamers supplied by the firm to the London Fire Brigade are of similar design to the new *Beta* engines, though, of course, of smaller capacity.

Each engine consists of two double-acting pumps, arranged vertically and connected to a corresponding pair of steam cylinders by stout standards of polished forged steel. Two



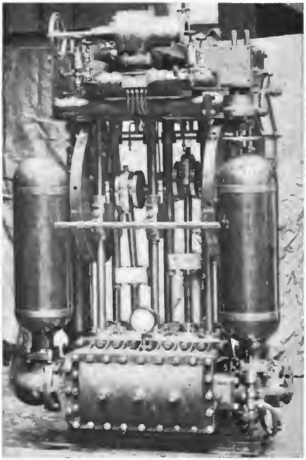
FRONT OF ONE OF THE FOUR PUMPING ENGINES.

piston rods convey the movement of each piston to the corresponding bronze cross-head, which is made solid with the

THE FIRE BOAT BETA, RECENTLY ADDED TO THE LONDON FIRE BRIGADE, SHOWING BIG MONITOR NOZZLE.
(Copyright, Reginald Haines, London.)

pump-rod, and a steel connecting rod jointed in the cross-head communicates the movement to the double-throw crank-shaft. Suitable fly-wheels on the crankshaft provide for regular working, and at the ends of the crankshaft are the eccentrics of the variable cut-off gear, the variations being effected by means of a lever and quadrant at side of steam cylinder, as shown in one illustration.

The pumps have large valve area, admitting of high speed and steady delivery of water at high pressure. These valves are readily accessible for examination or renewal by removal of one cover. Large copper air-vessels are fitted to suction and delivery branches. An automatic relief valve is



SIDE OF ONE OF THE FOUR PUMPING ENGINES.

fitted in addition to the by-pass connecting delivery and suction chambers, and relieves the pump of any excessive pressure due to the closing of outlets, use of small jets or other cause. The lubricating arrangements and other fittings are of the most complete and up-to-date character.

The fire-engine fittings on deck, supplied by the builders, include a large monitor nozzle of new design, which will take the full combined capacity of the pumps, and through which a powerful stream of water can be hurled a distance of some 300 feet. So efficient is the action of this monitor that notwithstanding the great pressure at which the water is thrown, the 3½-inch or 4-inch jet can be directed to any point or at any angle and controlled with the greatest ease.

Two smaller monitors of similar design to the large one, fitted with 1¾-inch or 2-inch jets, and capable of taking 1,000 to 1,200 gallons per minute each, are also fitted on the deck—one on either side. There are, in addition, eight separate delivery outlets to which lines of hose can be connected and run up into a burning building or vessel, enabling the firemen to deal with a fire at close quarters; or by means of long lines of hose from these outlets the float's pumping power and inexhaustible supply of water may be used with effect a qnarter of a mile or more from the waterside, should a large conflagration demand it.

Under ordinary conditions of working, the fire pumps of the *Beta* will, of course, draw their supply from the river by means of a fixed suction pipe, but an attachment is provided for flexible suction pipe, so that the fire float can be used at any time for salvage pumping.

The vessel is a specially designed boat, 100 feet in length over all, and of 16 feet beam, with a draft of 3 feet 3 inches. She has a speed of 11 knots and is propelled by two triple-expansion engines.

A Fire Boat for Genoa.

A powerful fire and salvage boat, built by Merryweather & Sons, London, for the Genoa Harbor Board, is capable of throwing twelve jets simultaneously, the largest single jets being 3 inches in diameter at the nozzle. This enormous stream of water was thrown to a height of about 200 feet.

The vessel is called the *San Giorgio*, has an over-all length of 74 feet, a beam of 16 feet 8 inches, and draft of 5 feet. Power is obtained from two Merryweather quick-steaming boilers, which supply the propelling engines, pumps and auxiliary machinery. The propelling engines are of the double-cylinder, vertical compound type, driving twin screws.

The fire pumps are of the double-cylinder horizontal "Greenwich" pattern, of a total capacity of 4,000 gallons per minute. They draw water from the side of vessel when in use for fire extinction, but when required for salvage operations suction is taken through flexible piping connected to two 6-inch deck connections. The pumps discharge through two monitors on deck, also through two distributing heads, each fitted with four outlets for the attachment of flexible hose. The monitors and pumps are entirely of gunmetal; the steam, exhaust and delivery pipes being of copper with bronze flanges.

In the speed trials of the *San Giorgio* the measured mile at Long Reach was traversed at 10 knots, with the safety valves lifting. A special feature is that the boilers, engines and machinery are all in duplicate, so that the vessel can be practically relied upon as being always in fit condition for service, as, in the event of any part of the installation requiring attention or adjustment, the corresponding relay can be at once utilized. By means of an oil-fired heater, a low pressure of steam can always be maintained in one of the boilers, enabling the vessel to get under way within fifteen minutes of an alarm. Steam at 120 pounds pressure can be raised in twenty minutes from cold water.

The accompanying table gives a list of fire boats at present in service in the New York City fire department:

Name	Length Overall.	Breadth.	Horse-power.	Capacity of Pumps.*
Zophar Mills	120	25	575	....
New Yorker	125	26	800	13,000
David A. Boody	106	23.9	240	6,500
Wm. L. Strong	111	24	338	6,500
Abram S. Hewitt	117	24	649	7,920
Geo. B. McClellan	112	24	650	6,000
Seth Low	99	23.9	265	3,500
James Duane	131	27	850	14,000
Thomas Willett	131	27	850	14,000

Another fire boat, slightly smaller than the *Duane* and *Willett*, is being built for the city. She is named *Cornelius W. Laurence.*

* Gallons per minute.

The Disappearance of Manila Lines on Board Ships.

BY ROBERT SANFORD RILEY.

So closely has manila rope been associated with ships, that it has become a symbol of things nautical. It may surprise some to know that there are now ships with practically no manila or hemp lines aboard. We have become accustomed to horseless carriages, wireless telegraphy, and now we are confronted with "ropeless ships." In the old days fiber ropes were universal, but now the age of steel has come, afloat as well as ashore, and the familiar ropes of manila or other fiber have given way to wire cable. It is some years since steel came into general use for standing rigging; now it is superseding manila even for the running rigging, as well as all other uses aboard ship.

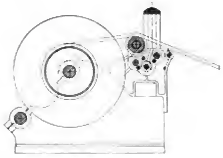
The steering gear is no longer connected up by manila lines, nor even by clumsy and noisy chains. The wire cable makes an ideal connection, being both strong and noiseless. Hoisting lines for all purposes are now regularly made of steel wire cables. The steel ash handling lines do not burn or dry out with intense heat. All the freight elevators and the new passenger elevators aboard ship are operated by wire cables. The awning on deck is strung on wire lines, and the life lines everywhere are generally made of steel.

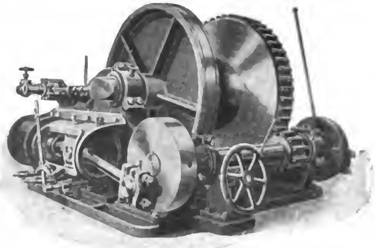
There are some uses to which wire cables have not yet been adapted, and perhaps never will be. We still depend on stout stud link chains for the most vital of all lines, the anchor cable. The steel cable cannot yet stand such chafing and abuse and still be so dependable as the chain cable. Nor can it safely lie so long unused and uncared for in damp chain lockers. But even in this respect it is better than fiber, for though it will rust it will never rot, and neither will it deteriorate in the hot places so common on steamships. There are many instances where fiber lines have actually rotted and become useless without ever being used. They are bulky and difficult to stow neatly, hence they are apt to be neglected and abused.

A wire line can be oiled and preserved indefinitely, and its easy stowing qualities are more apt to secure proper treatment for it. It is generally reeled on drums, which are thoroughly accessible and ready at all times for instant use or overhauling. A corresponding manila line would be dumped into some dark corner or locker, so as to keep it out of the way.

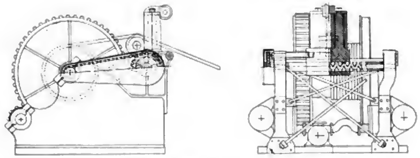
The greatest limitation for the use of steel rope is its rigidity. It will not stretch to any appreciable extent, and this renders it very susceptible to sudden shocks. Fiber will stretch before breaking, so that in case of a load suddenly applied it may "fetch up" gradually enough to save parting. This may be illustrated by figures: If a slow-moving ship is brought up with a manila line, it will probably stretch the line 6 inches or more, and during the stretching the ship is gradually losing way. The shock is absorbed in 6 inches, and the momentum may be considered as divided by the distance traveled. In the case of a steel cable, however, the ship would have to be brought up almost instantaneously, say in ⅛ inch; hence, the stress on the rope would be 48 times as great. This shows very clearly that, although the wire may have several times the strength of the manila for a steady pull, yet it has very little chance when it comes to a shock.

The many advantages of wire over manila, however, have led to the adoption of ingenious means for taking care of





TOWING MACHINE, BUILT BY THE AMERICAN SHIP WINDLASS COMPANY.



PROVIDENCE TOWING MACHINE, WITH PATENT AUTOMATIC WINDING DEVICE.

the shocks which cannot be avoided in handling ships. Incidentally, other advantages are obtained, chief of which are ease and speed of stowing. The lower cost and longer life of wire also appeal strongly to owners.

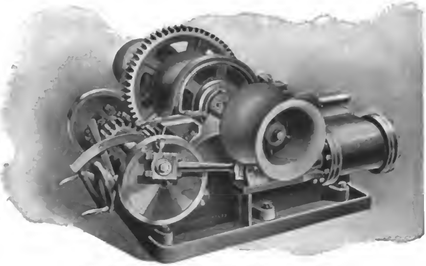
Perhaps the latest and most interesting elimination of manila is in the mooring of the large lake ships. Doubtless many deep-sea sailors, both in this country and abroad, are not aware that many big American lake freighters are now moored exclusively with wire cable. To do this the ships are equipped with "mooring machines." A mooring machine is simply a hoisting engine, with a drum for wire cable so arranged that the cable may be made fast and steam left turned on so as to maintain a steady pull on the cable. The cable serves as a breast or stern line in the usual way. It runs through fairleads at the rail back to the mooring engines, which are generally located nearly amidships. Should any sudden move occur, the cables will overhaul the engine against the pressure of the steam. The ship, therefore, is free to rise and fall, or otherwise accommodate herself to different conditions of load or tide. At the same time she is held in place without attention to the lines.

With the old method of mooring it is generally the duty of the mate or boatswain to stand by to see that the lines are slackened or taken up as required. So, in addition to cheapness and convenience, the machine automatically relieves the mate of his job of watching the lines. Of course, when ready to shove off, instead of the laborious hauling in of lines, a deck-hand simply moves the valve and the cable is neatly and speedily stowed where it bothers no one until required for use again.

Perhaps, however, the most important elimination of manila lines is in connection with the use of automatic steam towing machines. This is another American innovation of some years' standing, and is just beginning to be recognized and adopted abroad. All seagoing men are familiar with the advantage of using a towing machine instead of the old method of rigid connection between vessels at sea. This machine practically causes the line to pull against a steam cushion. If the pull becomes excessive the engine is overhauled; this opens an automatic valve, which admits more steam until the pressure is equalized and the engine begins to haul in again. Then, as the machine recovers the line, the valve is automatically closed until the line comes to rest at its normal position. It is a very simple device, and ideal for the purpose. Even in towing the drydock *Dewey* it was officially reported that the line came to rest exactly the same each time. The machine has made possible feats of towing which would not be thought of otherwise. It is a significant fact that nearly all towing companies who carry their own risks use towing machines.

The original development of the towing machine by the American Ship Windlass Company, of Providence, R. I., was the result of the demand for an elastic connection for towing vessels at sea. The idea of eliminating manila lines was not uppermost, and the wire cable was used simply because of its much greater convenience. Recent developments in the price of manila and labor, however, and the scarcity and uncertainty of both, have led to a new idea of the utility of towing machines. They still stand as absolute necessities for deep-sea towing, but further than this they are becoming recognized as great labor and time savers in the handling of lines. This is accomplished by having an ordinary reverse valve and lever, entirely separate from the automatic valve. It is thus possible to handle the machine as an ordinary winch or capstan, with the added advantage that the wire line is automatically taken care of by the machine itself. A newly-patented automatic reeling device lays the line as neatly and smoothly as on a spool of cotton. This, of course, saves the line from the severe bending it receives, even on an ordinary towing machine, where the reeling is left to chance or the tender mercies of a deck hand.

These new machines make possible the use of wire cable to such an extent that they are now regarded as lucrative investments rather than an equipment for special service. This is because wire lines cost less than manila, and last six or eight times as long. Harbor tugs are beginning to use them very extensively, especially in scow service. The enterprising dredging companies find that they can speed up their service very materially, simply by having a towing machine do the work of indifferent deck hands or firemen. The machine handles the lines so much more quickly that it is frequently possible to get in an extra trip a day, and in bad weather they keep right on towing instead of being obliged to lay up altogether. The old manila lines frequently parted, and were a continual source of expense and anxiety. Some of the up-to-date dredge outfits have no manila lines on board. They use mooring machines on the dredges and towing machines on the tugs, and claim a great saving in all respects. The present tendency is for this practice to become universal wherever possible. In this, as in many other things, the Great Lakes of America have set the fashion for dividend-paying innovations.



MOORING MACHINE, BUILT BY WILLIAMSON BROTHERS COMPANY.

The manufacturers of auxiliary machinery in America have always maintained a high standard, and their apparatus is known all over the world for its efficiency and labor-saving qualities. This is perhaps even more evident in the case of auxiliary machinery than in the ships themselves, although no one will dispute the excellence of the lake-built ships for their special purpose.

THE BATTLESHIP SOUTH CAROLINA, LAUNCHED FROM THE CRAMP SHIPYARD INTO THE DELAWARE RIVER.
(Photograph, Wm. H. Rau.)

The Battleship South Carolina.

On July 11 the second of the American "all big gun" battleships was launched by William Cramp & Sons, Philadelphia. This ship, which is a sister of the *Michigan*, launched in May, has a length of 450 feet on the waterline; a beam of 80 feet, molded; and a mean draft of 24 feet 6 inches. The displacement on this (trial) draft is 16,000 tons, while the full load displacement is 17,617 tons. Propulsion is by means of two four-cylinder triple expansion engines driving twin screws. The cylinders measure 32, 52, 72 and 72 inches in diameter, with a stroke of 48 inches. Steam is furnished by twelve Babcock & Wilcox watertube boilers at a pressure of 265 pounds to the square inch. These boilers have a total grate surface of 1,050 square feet, and a heating surface of 47,220 square feet, the ratio being 45 to 1. The designed indicated horsepower is 16,500, corresponding with a trial speed of 18½ knots. The normal coal supply of 900 tons can be increased to a maximum of 2,175 tons.

The main point of interest lies in the battery and its arrangement. There are eight 12-inch guns of 45 calibers, mounted in pairs in four turrets, all on the center line, the two inner turrets being raised above the end turrets, so that four guns may be fired forward, four aft, and the entire eight on either broadside. Each turret has an arc of fire of 270 degrees. The first and third turrets, counting from the bow, have their gun axes about 24 feet above the waterline. The second turret shows an axis of 32 feet above the line of flotation, while the after turret has its guns 16 feet above the water. The secondary battery includes twenty-two 3-inch guns; two 21-inch submerged torpedo tubes, and fourteen automatic guns. The broadside from the eight main guns is 6,960 pounds at one discharge, comparing with a broadside of 6,800 pounds for the *Dreadnought*, 7,000 pounds for the *Satsuma*, 6,790 pounds for the *Danton*, 9,120 pounds for the *Delaware*, and 9,912 pounds for the *Nassau*.

The waterline belt of armor extends from bow to stern. It is 8 feet wide, of which about 5 feet is below the normal waterline. The maximum thickness is 11 inches, tapering to 9 inches at the bottom. Above this belt, and covering the side for about 300 feet, is an upper belt, 10 inches thick at the lower edge and 8 inches at the upper, with 10-inch bulkheads running across the ship at the ends. The barbettes for the turrets are 10 inches on the face and 8 inches in the rear, while the turrets themselves are 12 inches in front and 8 inches in the rear. A conning tower 12 inches thick is fitted just aft of the second turret, and is provided with a 9-inch tube, protecting communications to the interior of the ship. The protective deck has a thickness on the slopes of 3 inches, and is 1½ inches thick forward.

The ships were authorized March 3, 1905, and contracts for construction were let in July, 1906. The keels were laid in December, 1906, and the contract calls for completion late in 1909. The contract price of hull and machinery for the *South Carolina* was $3,540,000 (£727,422), and for the *Michigan*, $3,585,000 (£736,670). In each case the cost of the completed vessel will be about $7,000,000 (£1,440,000).

Stranding of the Antonio Lanasa.

Early in the morning of March 23 the Norwegian freight steamer *Antonio Lanasa*, heavily laden with bananas, oranges and cocoanuts from Jamaica for Baltimore, went ashore on the south side of Cape Hatteras, in a southeast storm. The life-saving crew, working all day, succeeded in landing nine men, but the others, including Capt. Thomel and his wife, declined to go ashore, as a heavy sea was running at the time.

The wrecking steamer *Rescue*, of the Merritt & Chapman Derrick & Wrecking Company, reached the scene the following morning, but the sea was so high as to make it dangerous

THE ANTONIO LANASA ASHORE OFF HATTERAS.

to land on the beach. The rescuers stood by twenty-four hours, until the sea calmed down, when anchors and cables were laid from the steamer's port bow, and a 12-inch hawser to the *Rescue*. At the next high tide the ship's bow was moved off shore a few feet, but it was not until the cargo was jettisoned to lighten the vessel that she finally came off by degrees on April 11. She was towed to Norfolk for repairs.

The *Lanasa* was built last year by the Grangemouth & Greenock Dockyard Company, and measures 230 feet in length, 33 feet in width and 20 feet in depth. She is of 813 tons net and 1,261 tons gross. She is divided by watertight bulkheads into five compartments, and is electric lighted. The single screw is operated by a triple-expansion engine, with cylinders 19, 30 and 50 inches in diameter, and a common stroke of 33 inches. Steam is furnished by Scotch boilers operating at a pressure of 180 pounds per square inch. She hails from Bergen.

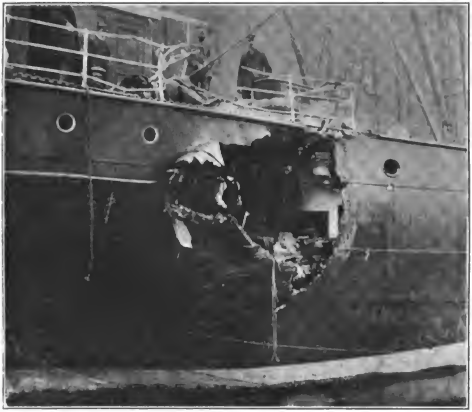
A Double Collision.

The steamer *James Joicey* collided with two different ships last Feb. 8, at night, just off the Yarmouth Roads. They were the *Syria* and the *Coronilla*. The photographs show that all three ships received considerable damage. All had to be brought to Yarmouth for repairs.

BOW OF THE JAMES JOICEY, SMASHED BY COLLISION.

The *James Joicey* is an iron schooner, with three masts, built by Palmer Bros., Newcastle, in 1863, and is owned by W. Cory

THE HOLE CUT IN THE SIDE OF THE STEAMER CORONILLA BY THE JAMES JOICEY.



THE HOLE IN THE SIDE OF THE SYRIA, AFTER COLLISION WITH THE JAMES JOICEY.

& Son, Ltd., London. Her gross tonnage is 731 and net 443. Her dimensions are: Length, 200 feet 6 inches; beam, 28 feet, and depth, 16 feet 8 inches. The triple-expansion engine has cylinders of 16, 26 and 43 inches, with a stroke of 36 inches. The boiler pressure is 150 pounds per square inch.

The *Syria* is an iron screw steamer, built by Raylton Dixon & Company, Middlesbrough, in 1889, and is owned by Thomas Wilson, Sons & Company, Ltd., Hull. Her gross tonnage is 2,239 and net 1,430. Her dimensions are: Length, 277 feet; beam, 38 feet 2 inches, and depth, 19 feet 2 inches. The triple-expansion engine has cylinders of 21, 34 and 56 inches, with a stroke of 39 inches. The boiler pressure is 160 pounds per square inch.

The *Coronilla* is an iron screw steamer, built by the Tyne Iron Shipbuilding Company, Newcastle, in 1878, and is owned by the Tyneside Line, Ltd. Her dimensions are: Length, 258 feet; beam, 32 feet, and depth, 21 feet. Her gross and net tonnages are, respectively, 1,312 and 822. She is propelled by a compound engine with cylinders 28 and 54 inches diameter by 33 inches stroke. The boiler pressure is 75 pounds per square inch.

James Fisher.

The Launching of the Tug Patuxent.

BY B. P. SCHLABACH.

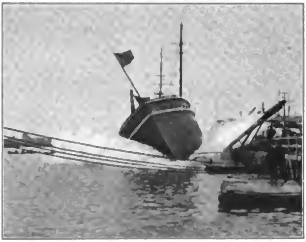
An interesting and rather unusual launching took place at the navy yard, Norfolk, Va., on May 16, when the tug *Patuxent* was put overboard for her initial plunge. She is a twin-screw, sea-going tug built of steel throughout, of the following dimensions:

Length, over all	155 feet 9 inches.
Breadth, extreme	30 feet 2½ inches.
Draft, full load	14 feet ¼ inch.
Displacement, full load	917 tons.

Her complement is to be 37 officers and men. She will be electric lighted and will be provided with a wireless outfit.

The *Patuxent* was laid down on ways running parallel to the sea wall, and the keel blocks are about 18 feet from the edge of the wall. To facilitate handling of material, a gantry crane of wood was constructed and an electric hoist fitted for same. Before launching it has been the custom to run the crane to one end and to remove all the supports on the water side except the two at one end, on which the crane is resting. In the present case, however, as the construction of no other vessel at this yard is authorized, the entire crane structure was removed.

The top of the sea wall was about five feet above the water at the time of launching, and as it was not practicable to run



THE LAUNCHING OF THE NAVY TUG PATUXENT.

the ground ways out into the river, it was necessary to drop the tug rather than slide her into the water. Six ground ways were provided; these ways were 15 inches wide and extended about 12 feet beyond the edge of the sea wall. About 25 feet from the outer end these ways were cut and scarfed to allow them to tip. These outer ends were well secured and shored to prevent their getting out of line with each other. Ribbands were fitted on both sides of the ways to prevent any tendency of the vessel to slew while sliding.

Cradles were fitted on the sliding ways, and the latter were well tied and cross-braced, so as to make a single cradle for the whole vessel. These sliding ways were 12 inches wide by 25 feet long, and the total bearing surface was thus 150 square feet. The weight of the hull at launching was 200 tons, and the weight of the sliding ways was 14 tons, the total launching weight being 214 tons, or 1.73 tons per square foot. At the time of launching, the hull was complete up to the main deck, but there was no machinery aboard, nor was the deck house in place.

The sliding ways were sufficiently weighted to insure sinking immediately and thus avoid any danger of injuring the vessel on any of the heavy timbers. Two triggers were fitted, one at each end. One end of the trigger was held by a chock on the end ground way, and to the other end was secured a line and tackle. About a foot from the end next the ground way was a shore running to the sliding way. A heavy strain was put on the lines, and by cutting both lines simultaneously the vessel was released and launched. Hydraulic jacks were set up hard against the inboard side to insure the vessel's starting when the lines were cut.

The tug took the water very easily and did not heel more than forty degrees, the main deck remaining perfectly dry. She righted herself at once and did not even take up the strain on the mooring lines, not having moved more than forty feet from the sea wall.

ON THE SIZE OF BATTLESHIPS.*

BY SIDNEY GRAVES KOON.

Much has been written recently regarding large battleships and their great adaptability to uses where smaller ships could be employed only with large increase of numbers. In general the discussions have dealt almost wholly with the question of gun power, and have either ignored the physical relations between large and small ships, or have covered them by implication only. It is proposed to take up a representative battleship, such as the *Michigan* in the United States navy, and to institute a number of comparisons between this ship and two ships, each of half the displacement of the *Michigan*, but designed under varying conditions so far as the principal military features are concerned.

In the first place, a design might be evolved in which the various percentages of weight used for the several elements constituting the displacement of the *Michigan* might be retained in the smaller vessels. A second design would call for the same battery as the first, the same speed as the type ship (*Michigan*), and such armor protection as might be available after making due provision for these other two features. A third design calls for the same battery as the first, and for protection equal to that given the *Michigan*, with such speed as can be obtained in connection with this battery and armor. The fourth design calls for the same speed and protection as in the *Michigan*, and for such battery as may be obtained after making provision for the other two items.

While the weights allotted to the various component portions of the *Michigan* are not public property, and cannot, therefore, be given with any exactness, yet a sufficiently close approximation for our purpose can be made, and whatever errors there may be in this statement of weights will by no means vitiate the comparison instituted. A schedule of weights assumed for the *Michigan* is given; this accounts for the total displacement of 16,000 tons.

	Tons.	Tons.*
Hull and fittings complete	6,400	*7,469*
Equipment and stores	800	*823*
Battery and ammunition	1,300	*1,118*
Protective deck	900	*in hull*
Vertical armor	4,200	*4,047*
Machinery and water	1,500	*1,643*
Coal	900	*900*

The *Michigan* has a length on the waterline of 450 feet, a beam molded of 80 feet, and a draft of 24 feet 6 inches. She is propelled by twin screws, the horsepower of the machinery being designed as 16,500, and the designed speed, 18.5 knots. The battery consists of eight 12-inch guns mounted in pairs in four turrets on the center line, in such a way that all can be brought to bear on one broadside. The secondary battery includes twenty-two 3-inch and fourteen smaller guns, besides two torpedo tubes. The protection includes a waterline belt with a maximum thickness of 11 inches, upper belt with maximum thickness of 10 inches, turrets and barbettes with thickness of 8 to 12 inches, and a protective deck with a maximum thickness of 3 inches.

The ratio between the length of one ship and the length of a ship of similar shape and half the displacement is 1 to 0.7937. Applying this ratio to the dimensions of the *Michigan*, we have for each of our smaller ships a length of 357 feet, a breadth of 63 feet 6 inches, and a draft of 19 feet 5 inches. Our first ship would have a schedule of weights, each item of which would be just one-half the corresponding item for the *Michigan*, as shown in the table for weights under the four different designs. This ship would, of course, have just half the *Michigan's* battery, namely, four 12-inch guns, eleven 3-inch, seven smaller and one torpedo tube. Its armor protection would cover the same proportionate area as that of the *Michigan*, each linear dimension, however, being proportionate to the corresponding dimension of the *Michigan*, in the ratio above given. This same ratio would affect the thickness of the armor everywhere, and the 11-inch belt would become 8.73 inches thick; the upper belt would have a maximum thickness of 7.94 inches; the turret and barbette armor would vary from 6.36 to 9.54 inches; while the maximum thickness of the protective deck would be 2.38 inches, in place of the 3 inches in the *Michigan*.

Not only would the armor be thus decreased in value as compared with the *Michigan*, but the speed would also be decreased, due to the fact that it is physically relatively more economical to propel a large vessel than a small one. This fact may be brought out by analyzing the expected speed performance of the *Michigan* by means of the Admiralty formula:

$$V^3 = \frac{H \times K}{D^{2/3}},$$

where V is the speed in knots; H is the indicated horsepower; D is the displacement in tons, and K is a coefficient of performance known as the Admiralty coefficient, and used for designing purposes. $D^{2/3}$ for the *Michigan* is 635; for each of the other vessels under consideration it would be 400; V^3 for the *Michigan* is 6,332; H for the *Michigan* is 16,500; K

* *The Engineering Magazine.*

* Later:—Figures in italics are believed to be correct.—EDITOR.

thus becomes 244. As the new ship has the same form as the *Michigan*, we may, without sensible error, assume that this same coefficient, 244, may here be used. On applying this to the formula, knowing that our horsepower is 8,250, we find that *V*, or the speed, becomes 17.14 knots, in place of the *Michigan's* 18.5 knots.

The second design calls for the same speed as the *Michigan*, namely, 18.5 knots. In this case, by using our formula, we find that the horsepower required is 10,380. This raises the weight necessary to be devoted to machinery from 750 tons to 944 tons. As the battery of this ship was to be unchanged, and the armor protection to be so adjusted as to fit the new conditions, the difference of 194 tons must be taken out of the provision for protective deck and vertical armor, thus reducing these two items to 416 and 1,940 tons, respectively. Assuming that each portion of the vessel is covered with armor of the same area as before, but of thickness reduced in the ratio of the weights allotted to armor, we find that the belt has been reduced from the original 11-inch maximum to 8.07 inches; the upper belt is reduced from a maximum of 10 inches to 7.34 inches; the turret barbette armor from 8 and 12 inches to 5.87 and 8.81 inches, and the protective deck from a maximum of 3 to 2.2 inches.

The third design uses the same armor schedule as in the *Michigan*, both as regards actual thickness and proportion of ship protected. This results in increasing the weight required for protective deck from 450 tons, under design 1, to 567 tons, and for the other armor from 2,100 tons, under design 1, to 2,646 tons. This total increase of 663 tons is made at the expense of the propelling machinery, the weight allotted to which thus becomes reduced to 87 tons. This accounts for only 957 horsepower, or a speed, from our formula, of only 8.35 knots. This shows what a very great diminution of speed must be expected if we are to retain in the smaller ship the same relative battery power and protection as in the larger.

The fourth design calls for the same speed and armor protection as in the *Michigan*, and the difference in weight is taken from that allotted to the battery. As found in the second design, the required horsepower is 10,380, calling for 944 tons of machinery. The armor weights will be the same as in the third design, namely, 567 tons for the protective deck, and 2,646 tons for the other armor. As we have made no change, throughout the series of designs, in weights of hull and fittings, equipment and stores and fuel, we still have for these items a total of 4,050 tons. Adding this to the above-mentioned figures for machinery and protection, the total becomes 8,207 tons, or 207 tons more than the designed displacement of the vessel. This means that, in order to float at the designed displacement with the same structure and equipment, an amount equal to 207 tons would have to be taken bodily from the vessel, or stores, or both; and it means, moreover, that there would be absolutely not one pound available for the provision of a battery of either heavy or light guns. Of course, it will be recognized that we have appropriated all the necessary weight for a splendid protection to such a battery, and that no designs would ever be evolved in which such protection would be provided without allowing for the battery itself. These figures have been worked out, however, simply for the

Item.	Type 1.	Type 2.	Type 3.	Type 4.
Hull and fittings.......	3,200	3,200	3,200	3,200
Equipment and stores..	400	400	400	400
Battery and ammunit'n.	650	650	650	— 207
Protective deck........	450	416	567	567
Vertical armor........	2,100	1,940	2,646	2,646
Machinery and water..	750	944	87	944
Fuel	450	450	450	*450

* Reduced to 243 on account of deficiency for weight of battery.

purpose of showing the immense sacrifices which have to be made in various directions in small vessels, in order to provide along other lines qualities similar to those obtained in vessels of larger size.

The figures above deduced show that under a given set of conditions the two small vessels, having the same total battery power as the one large, would require these sacrifices to be made along other lines:*

If there is the same proportionate weight for armor, there will be a sacrifice in the thickness of armor, amounting to nearly 21 percent; there will be a sacrifice in the speed amounting to about 8 percent. If the total battery power is to be the same, and the speed is also to be equal to that of the large vessel, there will be sacrifices in the armor protection, the reduction in thickness being about 27 percent. If the total battery is to be the same, and the armor protection equal to that of the large vessel, the sacrifice in speed will be tremendous—in fact, markedly greater than would ever be permitted in any design. The falling off would be more than 10 knots; that is, about 55 percent. If we have the same speed and the same protection for the two smaller ships that we have in the larger, there will be no weight available for battery, and our fuel supply will be cut off more than 45 percent.

This line of reasoning shows that there are other reasons besides those of mere gun fire which militate in favor of large ships as compared with small ones. If it were a question of gun fire alone, we might consider that a ship similar in design to the original monitor might be the ideal; for a fleet of such ships could bring all their guns to bear at any point of the compass, because the monitor had a practically unobstructed range of fire all around the horizon. As ships increased in size, demands came for a larger armament, and double-turreted monitors were the answer to the demand. The *Michigan* is the next in this direct line of development, although there have been many, many changes between. The double-turreted monitor design has had added to it a battery of broadside guns, only one-half of which in general could be brought to bear upon one broadside at a time. In the *Michigan*, however, we have gone back in general principle to the double-turreted monitor, carried one step further, for each of the four turrets has command over about three-fourths of the horizon. The small ships represented in the above figures would naturally be provided with two turrets each, instead of the four in the *Michigan*, and would have the same relative command of fire as in the latter ship. Whatever other battery is fitted in accordance with the above figures would be solely for the purpose of discouraging torpedo boats from too much inquisitiveness, and does not affect the general type evolved.

It has long been recognized that every man-of-war represents a compromise between conflicting military interests, and the science of naval architecture has not yet developed an ideal relationship between these interests, nor will it probably ever be reached. For some reasons, speed is an almost paramount consideration, while for other purposes the one item of prime importance is battery power. In either case a certain amount of the one must be associated with the other; for the speed is of no avail unless the battery be at hand to back it up, and the battery is of slight value unless the speed be sufficient to place it within reach of the enemy. Protection and battery go largely hand in hand, an increase in the latter calling usually for a corresponding increase in the former. This is not the case in extreme types, but it is a general principle. In all ships, however, certain sacrifices of one element have to be made to meet demands for excessive provision in another, and in no ship is this sacrifice more marked than in that of small size.

* The whole discussion presupposes that factors of safety are unchanged, and that the same type of machinery and fittings is employed in the small ships as in the large one.

The Largest Steamship Companies of the World.

BY SIDNEY GRAVES KOON.

Much interest centers in the large steamship companies, partly by virtue of the fleets of steamers which they operate, and partly because of the fact that this one or that one is frequently referred to as being of pre-eminent size. We have prepared some tables based on lists given in the 1907-08 edition of the Bureau Veritas, and showing all of the steamship companies of the world which have steamers of an aggregate of more than 80,000 tons gross. There are no less than sixty-nine of these companies, to which list we have added six, two of them because they possess steamers of upwards of 10,000 tons, and the other four because they are the largest companies operating, respectively, under the Brazilian, Chinese, Swedish and Turkish flags.

The first table shows seventeen companies having upwards of 200,000 tons in steamships of more than 100 tons each. Nine of these companies are British; three are German; two are French; one American; one Japanese, and one Italian. At the head of the list is the Hamburg-American Steamship Company, with 847,374 gross tons. The North German Lloyd Steamship Company stands second, being more than 200,000 tons behind the leader. The first British company is the British India Steam Navigation Company, which is again more than 200,000 tons behind the North German Lloyd. After this the intervals are smaller. In each case the average tonnage is given, as well as the tonnage of the smallest and of the largest vessels of the fleet.

The second and third tables are devoted to companies operating more than 100,000, but less than 200,000, gross tons of steamers. Twenty-one of these are British, in the second table, while the third table includes those of other countries. The fourth and fifth tables give, respectively, the British, and the other, companies with more than 80,000 tons gross. The sixth table gives the six lines included, as mentioned above, because of certain noteworthy characteristics.

The seventh table shows a recapitulation of the first six, giving the number of lines under each several flag; the number of ships; the total gross tonnage and the average gross tonnage. The second part of this table shows the number of large ships (10,000 tons and upwards) under each flag, with the total gross tonnage and the average tonnage of these large ships.

The eighth table is a development of this latter feature, and shows by companies the ships of over 10,000 tons gross, with total and average gross tonnage; percentage of total tonnage represented by these large ships; and the number of ships included, of over 15,000, and of over 20,000 tons gross, respectively. The White Star Line is shown here to have pre-eminence, with twenty vessels and 290,791 gross tons. The largest average is accredited to the Great Northern Steamship Company, the figure being 20,718 tons. This, however, is scarcely a fair rating, because of the fact that there is only one ship. Aside from this, the Cunard Steamship Company has the largest average, with 17,348 tons per vessel in eleven ships.

With regard to the general tables; we find that four companies have average tonnages exceeding 10,000, these being the White Star Line with 12,038, the Cunard with 10,193; the Holland-America Line with 12,044; and the Great Northern Steamship Company with 20,718. In nearly all cases the average is brought low, because of the inclusion of the figures for tenders. These are of more than 100 tons, but naturally operate very markedly to reduce the average for the entire number of ships. One conspicuous case where this does not so operate is that of Burrell & Son, in the fourth table. We find here twenty-two ships with an average of 4,376 tons gross, while the smallest ship is of 4,317 tons, and the largest of 4,432. There are other cases where the smallest ship is even larger than in this case (the Holland-America

TABLE I.—OVER 200,000 GROSS TONS.

	No.	Tons.	Average.	Small.	Large.
(b) Hamburg-American Steamship Co.	175	847,374	4,842	229	24,581
(b) North German Lloyd Steamship Co.	144	641,329	4,454	112	19,361
(a) British-India Steam Navigation Co.	111	440,391	2,967	192	7,703
(a) P. & O. Steam Navigation Co.	61	380,046	6,230	108	10,512
(a) White Star Line	29	349,091	12,038	395	24,541
(a) Elder, Dempster & Co.	108	308,979	2,861	107	7,585
(c) Messageries Maritimes	69	300,657	4,357	670	6,879
(a) Currie, Donald & Co.	47	265,222	5,642	158	12,975
(g) Consolidated Steamship Lines Co.	105	262,701	2,502	122	6,500
(d) Nippon Yusen Kaisha	90	261,300	2,903	109	7,463
(e) Navigazione Générale Italiana	101	253,518	2,510	165	9,203
(a) Ellerman Lines	61	249,759	4,094	739	9,700
(a) Cunard Steamship Co.	24	244,640	10,193	287	31,938
(b) Hansa Steamship Co.	53	234,696	4,428	158	7,217
(c) Compagnie Générale Transatlantique	61	218,660	3,585	278	12,753
(a) Ocean Steamship Co.	38	212,618	5,595	405	9,017
(a) Leyland Line	37	209,587	5,665	2,800	10,418

(a), British; (b), German; (c), French; (d), Japanese; (e), Italian; (g), American.

TABLE II.—OVER 100,000 GROSS TONS.

British.	No.	Tons.	Average.	Small.	Large.
T. & J. Harrison	39	195,514	5,012	618	9,599
Pacific Steam Navigation Co.	45	183,541	4,079	214	9,266
Clan Line	45	183,324	4,074	2,600	5,856
Thos. Wilson, Sons & Co.	83	181,384	2,185	155	6,035
Canadian Pacific Railway Co.	35	180,094	5,146	366	14,191
Royal Mail Steam Packet Co.	43	179,328	4,170	180	11,073
Furness, Withy & Co.	59	173,238	2,936	892	5,520
Allan Line	30	170,226	5,674	233	11,436
Wm. Thomson & Co. Lines	46	147,387	3,204	1,010	4,369
R. Ropner & Co	44	136,390	2,100	1,782	4,621
Union Steamship Co. of New Zealand	63	132,812	2,108	112	6,500
Maclay & Macintyre	42	130,858	3,116	1,509	4,846
China Navigation Co	66	126,501	1,917	269	3,397
Lamport & Holt Line	29	125,600	4,331	1,671	8,406
Anchor Line	24	122,907	5,121	3,069	9,250
Anglo American Oil Co.	26	111,748	4,298	339	9,196
Bucknall Bros.	26	107,960	4,152	621	5,588
Prince Line	42	105,653	2,516	1,888	6,409
New Zealand Shipping Co.	16	104,383	6,524	3,393	8,349
Watts, Watts & Co.	30	103,744	3,458	1,940	4,881
Hain Steamship Co.	34	100,762	2,964	2,098	3,896

TABLE III.—OVER 100,000 GROSS TONS.

Foreign.	No.	Tons.	Average.	Small.	Large.
Lloyd Austria Co. (Austrian)	65	194,485	2,992	186	7,588
(b) Hamburg-So. American S. S. Co.	41	182,755	4,457	125	9,700
(b) Kosmos Steamship Co.	35	167,329	4,781	3,047	6,982
(g) International Mercantile Marine*	18	164,147	9,119	163	12,760
Danish-American Line (Danish)	119	152,557	1,282	110	10,095
(b) German-Australian Steamship Co.	31	137,289	4,429	4,187	5,155
Chargeurs Reunis (French)	33	135,260	4,099	498	5,594
(i) Compagnie Russe de Navigatione	80	119,935	1,499	156	5,090
(i) Flotte Volontaire Russe	22	109,026	4,956	1,523	10,982
Holland-America Line (Dutch)	9	108,428	12,044	6,280	24,200
Osaka Shosen Kaisha (Japanese)	103	107,065	1,039	101	3,376

(b), German; (g), American; (i), Russian. * Includes several vessels of the Red Star Line operating under the British and Belgian flags.

TABLE IV.—OVER 80,000 GROSS TONS.

British.	No.	Tons.	Average.	Small.	Large.
China Mutual Steam Navigation Co.	17	96,692	5,688	3,883	9,021
Burrell & Son	22	96,275	4,376	4,317	4,432
Indo-China Steam Navigation Co.	40	95,660	2,392	1,065	4,895
Booth Steamship Co.	34	94,845	2,790	875	6,439
James Westoll	37	93,097	2,616	949	3,920
R. P. Houston & Co.	25	92,662	3,706	2,279	5,756
T. E. Radcliffe & Co.	26	91,151	3,506	1,823	5,084
Atlantic Transport Co	13	90,448	6,956	2,847	13,403
Runciman, Walter & Co.	26	89,056	2,425	2,733	4,119
A. Weir & Co.	21	81,537	3,883	425	6,235

TABLE V.—OVER 80,000 GROSS TONS.

Foreign.	No.	Tons.	Average.	Small.	Large.
(b) Woermann Line	40	99,371	2,484	171	6,225
(h) Nederland Steamship Co	23	99,330	4,319	832	6,500
W. Wilhelmsen & Co. (Norwegian)	31	93,929	3,030	1,605	4,275
(g) American-Hawaiian Steamship Co.	13	90,252	6,942	4,409	8,671
(f) Unione Austriaca di Navigazione	25	89,505	3,580	679	6,125
(g) Pacific Mail Steamship Co.	18	88,390	4,911	202	12,636
(b) German East Africa Line	23	87,036	3,784	226	6,387
(g) Southern Pacific Company	21	85,584	4,075	152	6,678
Compañia Trasatlantica (Spanish)	23	85,396	3,713	466	6,748
(c) Société Générale de Transports	26	80,620	3,101	290	5,550

(b), German; (c), French; (f), Austrian; (g), American; (h), Dutch.

Line has nothing under 6,280 tons), but nowhere else is there such a very marked uniformity in the size of the ships.

By excluding all vessels of under 1,000 tons gross, the White Star average tonnage becomes 12,225; and the Cunard, 11,079; while the Holland-America figure remains at 12,044, and the Great Northern at 20,718. This exclusion raises the average tonnage of Dutch ships in the tables to 6,675, retaining first position in this regard.

The Consolidated Steamship Lines Company, which is credited with the ninth position in the list of large lines, is a recent consolidation of several coastwise lines on the east coast of the United States, and is said to be in fiscal difficulties.

THE HOLE OPENED UP IN THE PORT BOW OF THE OTTAWA, IN COLLISION WITH THE TROLD.

TABLE VI.—OTHER NOTABLE LINES.

	No.	Tons.	Average.	Small.	Large.
(*g*) Great Northern Steamship Co.	1	20,718	20,718	20,718	20,718
Aberdeen Line (British)	7	42,468	6,067	3,726	11,400
Lloyd Brazileiro (Brazilian)	34	51,885	1,526	240	3,840
(*l*) China Merchants Steam Navigation Co	30	55,347	1,845	505	2,373
Axel Broström & Son (Swedish)	26	49,406	1,900	331	4,134
Idaria Massousieh (Turkish)	40	44,685	1,117	114	4,580

(*g*), American; (*l*), Chinese.

TABLE VII.

	Lines.	Ships.	Tons.	Average.	Large Ships.	Average.	Largest.
Britain	41	1,651	6,627,579	4,014	46—676,021	14,696	31,938
Germany	8	542	2,397,179	4,821	29—405,486	13,982	24,581
France	4	189	735,197	3,890	3— 36,067	12,022	13,753
America	6	176	711,792	4,044	15—187,833	12,522	20,718
Japan	2	192	368,365	1,908	....	......	7,463
Austria	2	90	283,990	3,155	....	......	7,588
Italy	1	101	253,518	2,510	....	......	9,203
Russia	2	102	228,961	2,245	1— 10,982	10,982	10,982
Holland	2	32	207,758	6,492	6— 89,268	14,878	24,200
Denmark	1	119	152,557	1,282	2— 20,180	10,090	10,095

TABLE VIII.—SHIPS OVER 10,000 TONS GROSS.

	No.	Tons.	Average	*m*	*n*	*r*
(*a*) White Star Line	20	290,791	14,540	83.3	2	4
(*b*) Hamburg-American Line	14	210,384	15,027	34.8	2	2
(*b*) North German Lloyd Co.	15	196,102	13,007	30.4	3	..
(*a*) Cunard Steamship Co	11	190,832	17,349	78.	2	2
(*g*) American Line (including Red Star)	10	117,541	11,754	71.6	..	..
Holland-America Line (Dutch)	6	89,268	14,878	82.3	1	1
(*a*) Currie, Donald & Co.	5	61,127	12,225	23.	..	..
(*a*) Pacific Mail Steamship Co	4	49,574	12,394	56.1	..	..
(*c*) Compagnie Générale Transatlantique	3	36,067	12,022	16.5	..	..
(*a*) Royal Mail Steam Packet Co.	3	31,647	10,549	17.6	..	..
(*a*) Canadian Pacific Railway Co.	2	28,380	14,190	15.8	..	..
(*a*) Peninsular & Oriental Co.	2	21,021	10,511	5.5	..	..
(*a*) Leyland Line	2	20,823	10,412	9.9	..	..
(*g*) Great Northern Steamship Co	1	20,718	20,718	100.0	..	1
Danish-American Line (Danish)	2	20,180	10,090	12.2	..	..
(*a*) Aberdeen Line	1	11,400	11,400	26.9	..	..
Russian Volunteer Fleet (Russian)	1	10,982	10,982	10.1	..	..

(*a*), British; (*b*), German; (*c*), French; (*g*), American. *m*, percentage of total tonnage in ships of over 10,000 tons gross; *n*, number of ships between 15,000 and 20,000 tons; *r*, number over 20,000 tons gross.

Collision Between the Ottawa and the Trold.

The fog-bound waters of the entrance to the St. Lawrence have witnessed another serious collision, that between the Dominion Liner *Ottawa* and the collier *Trold*, which occurred May 11. Both vessels were severely injured, and the *Ottawa*, which was on its way from Quebec, was obliged to put back, while the collier made its way to Gaspe Basin, the nearest port. Our photograph of the bow of the *Ottawa* shows the serious extent of the damage, the cut being so extensive as to flood the forepeak and hold No. 1. This gave her a decided trim by the head, resulting in a draft forward of at least 30 feet, and reduced her speed to below 7 knots.

The *Trold* was bound for Quebec from Sydney, Australia, with a heavy cargo of coal, and she also was partially flooded, and down by the head.

The *Ottawa*, which was built in 1874 by Harland & Wolff, of Belfast, was formerly the *Germanic*, used in the New York service. She is an iron screw steamer with eight watertight bulkheads and provision for water ballast. She measures 455 feet in length, 45 feet 2 inches beam, and 34 feet depth. Her gross and net tonnages are respectively 5,071 and 2,909. She has one triple expansion engine with cylinders 35½, 58½ and 96 inches in diameter, and a stroke of 69 inches.

The *Trold* is a steel screw steamer, flying the Norwegian flag, and built in 1898 by J. Priestman & Company, Sunderland. She has five watertight bulkheads and is fitted with web frames. She is schooner-rigged, and fitted with poop, bridge and forecastle. The length is 325 feet, beam 47 feet, and depth 25 feet 6 inches. The net and gross tonnages are respectively 2,075 and 3,247. She is propelled by one triple-expansion engine with cylinders 25, 41 and 67 inches in diameter and a stroke of 45 inches.

The *Trold* reached New York early in June, and was repaired at the Erie Basin, in South Brooklyn.

INTERNATIONAL MARINE ENGINEERING

Published Monthly at

17 Battery Place New York

By MARINE ENGINEERING, INCORPORATED

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President

E. L. SUMNER, Secretary

and at

Christopher St., Finsbury Square, London, E. C.

E. J. P. BENN, Director and Publisher

SIDNEY GRAVES KOON, Editor

Branch Offices { Philadelphia, Machinery Dept., The Bourse, S. W. ANNESS. Boston, 170 Summer St., S. I. CARPENTER.

Entered at New York Post Office as second-class matter.

The edition of this issue comprises 6,000 *copies. We have no free list and accept no return copies.*

Lake Passenger Steamers.

The Great Lakes of North America and the numerous small lakes and navigable rivers along and near the Atlantic coast have given rise, as a means of rapid and ready communication, to a fleet of magnificent steamboats, many of which can be said to be without an equal anywhere in the world. The lake type of steamer for freight purposes is well known, being a highly specialized unit of great carrying power and particular utility for the purpose for which it is intended. The passenger steamers on the lakes, however, are not by any means this same type of vessel. They are built for runs varying in general from 150 to nearly 2,000 miles, and, in the latter case, resemble transatlantic liners, though of considerably smaller size.

It is with the vessels intended for the shorter runs, however, that we are here concerned. These steamers are propelled, some of them by paddle wheels, some by propellers, and, in one or two isolated cases, the propellers are actuated by steam turbines. The typical American lake, sound and river steamer, however, is one in which paddle wheels are relied upon for propulsion, because of the fact that in many cases the waters to be traversed are shallow, and, the cargo carried being relatively small, there is not much difference in immersion of the paddle-wheel blades between full load and light load conditions.

Among the most prominent of the steamers of this type is the *City of Cleveland*, built by the Detroit Shipbuilding Company early in 1907, only to be destroyed by fire, as briefly mentioned in our issue of July, 1907. The vessel was promptly rebuilt, and our description of her this month shows a magnificent example of the lake steamer, providing accommodation for some hundreds of passengers during the night trip, and a much larger number during the day trip. This vessel makes the run between Detroit and Cleveland, on Lake Erie, a distance of approximately 110 miles, twice a day, and is capable of a maximum speed, which is called for during the day trip, of nearly 22 miles per hour (19 knots).

In May of 1906 we described at some length the Hudson river steamer *Hendrick Hudson*, which is from the boards of the same designer, and which has made a splendid record on the river during her first two seasons of operation. This vessel is intended entirely for day service, and has accommodations for carrying 5,000 passengers. The contract called for a speed of 20 knots, which has been easily exceeded in the daily runs. In this case, as with the *City of Cleveland*, the propelling engine is of novel type, being a three-cylinder compound, working directly on the paddle-wheel shaft without the intervention of the usual walking beam. The cylinders are inclined to the horizontal, and are placed low down in the hold, thus aiding stability, and tending to counteract the fact that broad decks for the accommodation of passengers reach high up into the air above the shallow and relatively narrow hull.

A steamer somewhat similar in type is the *Commonwealth*, of the Fall River Line, operating through Long Island sound between New York and Fall River. This is considerably larger than either of the others mentioned, having a gross tonnage of 5,980, as compared with 4,568 for the *City of Cleveland* and 2,847 for the *Hendrick Hudson*. She has a length over all of 456 feet, a width of hull of 55 feet and a depth of 22 feet. As illustrating the immense breadth of the decks, it may be stated that her width over the paddle-wheel guards is no less than 96 feet, this indicating an overhang of more than 20 feet on each side. The *Commonwealth* has engines developing a total of 11,000 horsepower, which is 2,500 more than the next most powerful among the paddle steamers of this type (the *Priscilla*, of the same line), and is about double that

of the *Hendrick Hudson*, and nearly double that of the *City of Cleveland*.

Scout Cruiser Trials.

In another column will be found a brief description of the official trial trips of three scout cruisers recently commissioned for service in the United States navy. These vessels are all provided with hulls identical in dimensions and form, and are driven by three different types of propulsion; one having twin screws with reciprocating engines; another, twin screws with Curtis turbines; while the third has four screws and Parsons turbines. In each case the designed horsepower was 16,000, which figure was considerably exceeded by the two turbine-propelled ships.

The chief interest in these ships lies in the splendid opportunity for comparing results of propulsion by these three different agencies. Not only have we the comparison afforded by the results of the trial trips, but it is proposed to run the ships through a series of trials side by side, thus insuring identical weather and other conditions, with a view to determining beyond the peradventure of a doubt, at least so far as the present installations are concerned, the relative efficiencies of the three propulsive agencies, both as regards possibilities for extreme economy of obtaining the power, and as regards speed and for overload, this latter feature limiting the steaming or scouting radius.

It is not at all improbable that the information derived from these series of tests will be made use of, in connection with possible changes in the propellers, in the designing of the next large warships placed under construction for the United States navy. Several sets of propellers have been tried on some of these scouts, but it is quite unlikely that the ultimate maximum of efficiency has yet been attained on any of them, and the trials ought to demonstrate in just what particulars better results might be looked for.

Fire Boats.

In this issue we are describing a number of small vessels fitted with fire-fighting appliances and intended for use in connection with fires along the water fronts of some of the largest cities in the world. It is now some years since the *New Yorker*, long the most powerful vessel of this type in existence, and even now, so far as we are aware, exceeded in power by only two boats of her sister fleet, was put into service in the harbor of New York. At the time of her inception, the idea was by no means novel; for we understand that vessels of this general character have been in use on the Thames for a full half century. In spite, however, of this lack of novelty, the *New Yorker* presented so many interesting features, by virtue of her great power and general efficiency, that she has been repeatedly referred to as the leading exponent of this particular means of fighting fires.

The conditions attending the design of such a vessel are more or less peculiar. In the first place, there must be provided propulsive power for a rapid approach to the scene of action; after this, the propulsive machinery is needed scarcely at all, for the warping of the vessel into more advantageous positions for fighting the fire can usually be done by means of lines. At this time, however, a large amount of power is required for the operation of the pumps, and, in the Chicago fire boat, described this month, a novel arrangement has been entered into by which the same prime movers are used for both purposes. These are steam turbines direct connected to both centrifugal pumps and electric generators. As a general proposition, while the generators are under service, furnishing power to the motors on the propeller shafts, no power is required for the pumps, and the impellers run idle, with very little loss by friction. On the other hand, while the boat is fighting a fire, and the pumps are in full service, the propellers are normally at rest, and, as their motors are not drawing current from the generators, the latter run idle, again with very little friction. So we have a set of machinery thoroughly well adapted to the particular purpose, and which may on emergency be used momentarily for both propelling and pumping at the same time. The flexibility of such a system is very great, because of the ease of control from the pilot house of the main propulsive elements, without the necessity of transmitting orders through the engine room.

Continental Passenger Traffic.

Once more the oft-repeated rumor is afoot to the effect that the Cunard Steamship Company is about to seek an opening in the channel, in order to compete with other lines in the continental passenger traffic, which is said to be the "cream" of the whole Atlantic business. The new report, which is officially denied, is to the effect that, without abandoning Liverpool as a terminus, Queenstown is to be dropped and stops at Plymouth and Cherbourg substituted. The Plymouth stop would expedite the carriage of the mails between New York and London, while that at Cherbourg would tap the continent and provide ready access to Paris and the tourist resorts of the north of Europe.

If such a change is made, the eastern end of the Cunard route doubles back on itself, Cherbourg being about 180 nautical miles to the east of the Scilly Islands, where the turn up to Liverpool would be made. This would involve so much in the way of delay for the fast steamers making it as to amount to a positive nuisance. The ideal method of attacking the problem would seem to be that adopted by the White Star Line, which, without abandoning Liverpool, has a service to channel ports as well, this latter service being distinct from that to Liverpool, and no steamer making both "termini," so to speak, on any one trip. This involves a larger fleet of vessels than would be required for the single service, but the Cunard Company has such a fleet already in being, and could readily institute such a change.

Progress of Naval Vessels.

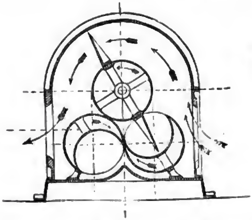
The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States Navy:

	Tons.	Knots.		July 1.	Aug. 1.
BATTLESHIPS.					
South Carolina..	16,000	18½	Wm. Cramp & Sons..........	51.9	55.
Michigan.......	16,000	18½	New York Shipbuilding Co.....	57.2	60.4
Delaware.......	20,000	21	Newport News S. B. & D. D. Co.	31.6	35.3
North Dakota...	20,000	21	Fore River Shipbuilding Co. ..	40.5	45.7
ARMORED CRUISER.					
Montana.......	14,500	22	Newport News Co............	99.2	100.
SCOUT CRUISER.					
Salem..........	3,750	24	Fore River Shipbuilding Co. ...	98.9	100.
TORPEDO BOAT DESTROYERS.					
Number 17.....	700	28	Wm. Cramp & Sons...........	31.1	38.7
Number 18.....	700	28	Wm. Cramp & Sons...........	26.9	35.7
Number 19.....	700	28	New York Shipbuilding Co.	33.8	42.2
Number 20.....	700	28	Bath Iron Works.............	13.	14.
Number 21.....	700	28	Bath Iron Works.............	13.	14.
SUBMARINE TORPEDO BOATS.					
Number 13.....	—	—	Fore River Shipbuilding Co	49.3	51.9
Number 14.....	—	—	Fore River Shipbuilding Co. ...	49.4	51.9
Number 15.....	—	—	Fore River Shipbuilding Co....	48.6	50.9
Number 16.....	—	—	Fore River Shipbuilding Co	48.8	51.1
Number 17.....	—	—	Fore River Shipbuilding Co	35.8	42.4
Number 18.....	—	—	Fore River Shipbuilding Co.....	32.6	41.8
Number 19.....	—	—	Fore River Shipbuilding Co.....	31.7	41.2

ENGINEERING SPECIALTIES.

A Rotary Pressure Blower.

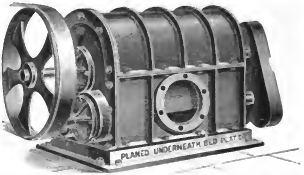
A device placed on the market by the Baker Blower Engineering Company, Stanley street, Sheffield, is designed for the moving of heated air and gases, and is supplied with outlet delivery on either side, as viewed from the driving pulley.



These blowers are said to be simple and not liable to get out of order, having no sliding vanes or pistons working under pressure internally, and, therefore, subject to wear and tear. A great volume of air is passed at a low speed. All the working parts requiring attention and lubrication are external. The internal arrangements can be seen by removing the top cover, without disturbing either inlet or outlet connection.

The internal parts do not move in absolute contact, but are so close as to be practically tight. This results in confining the wear to the journals and gear, where ample surfaces are provided, all adjustable from the outside. The shafts are large in diameter and have adjustable stuffing boxes, while the revolving drums are carefully balanced.

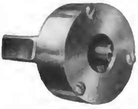
The blowers are listed in regular sizes rated from 3,000 to 780,000 cubic feet of air per hour against a head of 6 inches of water. The requirements vary from ½ to 23 horsepower at respectively 300 and 130 revolutions per minute. The approximate over-all dimensions for the smaller size are 18



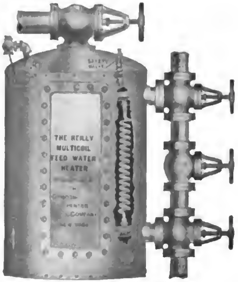
by 6¾ inches by 10 inches high; for the larger size, 127 by 81 inches by 96½ inches high. The weights increase successively from 1¼ to 220 cwt.

A Reversible Stay-bolt Chuck.

It frequently happens when running in a stay-bolt that the bolt will stick and stop and must be backed out part way in order to get a fresh start. The reversible stay-bolt chuck manufactured by the Cleveland Pneumatic Tool Company, Cleveland, Ohio, is designed to be operated in either direction at will. The necessary grip on the bolt is obtained by a loose roller, which changes its fulcrum automatically, and wedges the bolt fast against the two stationary dogs. When the motor to which the chuck is attached is reversed, the roller of the chuck releases its hold and moves to the opposite side, when it again grips the bolt fast. This chuck is designed to drive stay-bolts from ¾ to 1⅛ inches in diameter. It can be applied directly to standard bolts, without the necessity of squaring the ends.



CLEVELAND REVERSIBLE STAY-BOLT CHUCK.



The Reilly Multicoil Feed Water Heater.

The matter of feed-water heating on shipboard is a most important detail, for as much as 28 percent of the total work of making steam is generally devoted to raising the temperature of the water up to the boiling point. If the water could be fed to the boilers at the temperature at which steam is made, the steaming capacity of the boiler could be increased by just about this percentage. If also a part of this work of heating the water can be done by the use of exhaust steam that would otherwise be wasted and merely thrown into the condenser, requiring more work to condense it, besides losing all of the valuable heat stored up in it, the feed-water heater is justified.

The Griscom-Spencer Company, New York, manufactures the Reilly multicoil feed-water heater, which has recently undergone decided improvement in economy and weight. The union joint connection between each copper heating coil and the top and bottom headers of the heater has been improved in one or two details, and the door construction has been changed from the old method of bolting the cast-iron door frame to the shell to a more modern method of flanging out the shell itself into a kind of nozzle, and riveting to this nozzle a welded angle iron collar, which makes a seat for a light door of pressed steel plate. This construction is very light, and is a most neat and workmanlike job.

The builders have gone deeply into the subject of the economy of feed-water heating and its relation to modern power plants, both scientifically and practically. From the data that they have compiled in their experiments and in their marine experience, they assert that a Reilly multicoil heater will pay for itself under general conditions in about forty-one working days, and after that all the saving in fuel, as well as the saving in boiler repairs due to feeding hot water instead of cool water to the boilers, is net profit.

TECHNICAL PUBLICATIONS.

Definitions in Navigation and Nautical Astronomy. By P. Groves-Showell. Size, 5¼ by 7¼ inches. Pages, 107. Figures, 96. Philadelphia, 1908: J. B. Lippincott Company. Price, $1.25; and London, Charles Griffin & Company, Ltd. Price, 2/6 net.

This work gives special consideration to students desiring to present themselves for examinations for a marine officer's certificate. It is divided into three parts, dealing respectively with definitions, instruments and miscellaneous items, and is followed by an index. Under definitions are taken up spheres and angles, general considerations of navigation, including departure; great circle sailing; deviation of the compass; leeway, etc. Under nautical astronomy are definitions of such terms as altitude, zenith distance, azimuth, equinoctial, ecliptic and right ascension. Time is next given consideration, while charts are given showing lines of magnetic variation and magnetic dip.

Under the head of instruments are shown the mariner's compass, chronometer, sextant, the use of the vernier, sounding machine, patent log, barometer and thermometer. The miscellaneous section gives tables of weights and measures, and rules for finding areas and volumes of figures of various shapes.

Beeson's Marine Directory of the Northwestern Lakes. Size, 6¼ by 9½ inches. Pages, 272. Illustrations, 66. Chicago, 1908: Harvey C. Beeson. Price, $5.00 (£1).

This is the twenty-second year of publication of a directory of all the steam and sailing vessels on the Great Lakes, including both American and Canadian craft. Under separate headings are the iron ore carriers, lumber vessels and particulars of boilers and machinery of the steam vessels on the lakes. Statistics are given showing the traffic through the Sault Sainte Marie canals, and notes covering the various steamboat and transportation lines on the lakes. The illustrations are mostly half-tones, representing subjects peculiar not only to the lakes but also to the ocean, including passenger and freight steamers, steam and sailing vessels, lake, ocean, coastwise and river craft, motor boats, yachts, machinery and a number of vessels, interesting principally from the point of view of their antiquity or oddity of design.

The main new feature this year is a descriptive list of all the American ports on the Great Lakes, with details of population, commerce and other items of interest.

Hydraulics. Vol. II. The Resistance and Propulsion of Ships. By S. Dunkerley, D. Sc. Size, 5½ by 8¼ inches. Pages, 253. Figures, 115. London and New York, 1908: Longmans, Green & Company. Price, 10/6 net and $3.00.

The first volume dealt with hydraulic machinery. This second one is divided into six chapters, followed by a complete index. These chapters deal respectively with stream lines, waves, the eddy, skin and wave-making resistance of ships, wave-making resistance, trials on full-sized ships, and theoretical considerations affecting the propulsion of ships. The first chapter takes up the subject from a theoretical point of view, with the aid of the calculus. It is followed by a chapter dealing with waves in both deep and shallow water, and including waves of translation, oscillating and capillary waves, etc. The trochoidal wave system is given considerable space, and the subject of the velocity of propagation is dealt with at some length. The resistance, due to eddies and waves, forms the subject of a chapter in which Froude's classic experiments are given prominent place.

In the fifth chapter the laws of comparison are taken up, showing the relation between sizes and corresponding speeds and the method of passing from one size to another, or one speed to another, in calculations. Under theoretical considerations appears a discussion of types of propellers, including the jet propeller, paddle wheel and screw propeller. The first two are given the usual brief attention, while the third naturally occupies the bulk of the chapter. Among other things discussed are the effect of the thickness of blade and methods of testing model propellers, either with or without an attendant hull. The Admiralty method of designing screw propellers is outlined, while the end of the chapter is concerned with a discussion of such abnormal phenomena as cavitation and the rapid rotation of propellers in heated water.

The Slide Rule—A Practical Manual. By Charles N. Pickworth. Pages, 113 + xvi. Figures 30. Size, 5 by 7 inches. New York, 1908: D. Van Nostrand Company. Price, $1.00 net. London: Whittaker & Co., and Manchester, Emmott & Co., Ltd. Price, 2/6.

This is the eleventh edition of a work dealing with the use of a calculating rule, and takes up in considerable detail the methods of procedure in making computations by this means. Nearly all of the volume is devoted to the usual type of slide rule, being that in the form of a ruler 10 inches long. Special types of rules, however, are given at the end of the volume: the Fuller spiral rule, the Thacher cage-type calculating instrument and a number of circular calculators of the size and form of a watch being here described. Numerous examples are given, with explanations in detail of the method of obtaining results.

Board of Trade Arithmetic for First-Class Engineers. By Peter Youngsen. Pages, 108. Figures, 19. Size, 4¾ by 7 inches. Glasgow, 1908: James Munro & Co. Price, 3/- net and $1.00.

The work consists of a series of sixteen papers of questions asked at Board of Trade examinations for engineering licenses. Each paper consists of a considerable number of questions, and is followed in the second portion of the work by answers to these questions. The questions cover computations and explanations of various boiler calculations, size of coal bunkers, coal consumption, propeller data, engine horsepower and elementary navigation, besides a large number of questions of a general arithmetical nature, and dealing largely with marine engineering subjects.

In the preface it is pointed out that the carrying out of results to a large number of decimal places is not usually called for, and stress is laid upon the importance of carefulness in the steps leading up to the result rather than too much refinement in the result itself.

Signal Manual for the Use of the Mercantile Marine. By Capt. W. G. Rugg. Pages, 28. Figures, 9 (four in colors).

Size, 4½ by 6 inches. Glasgow, 1908: James Munro & Co. Price, 1/- net and 30 cents.

This little pocket manual is the second edition of a work giving instructions in the making of signals with flags by means of spelling them out, or of sending messages by codes. The use of the semaphore fixed to a mast or in the shape of a man with flags is taken up, this being based largely on the Morse code. A number of special signs and methods of flashing signals by lights are also mentioned. The international code of alphabetical and special one-flag, two, three and four-flag signals is illustrated in colors (white, black, red, blue and yellow).

Consular Requirements for Exporters and Shippers. By James Shaw Nowery. Size, 5 by 7½ inches. Pages, 84. Glasgow, 1908: James Munro & Co. Price, 2/6 net; 75 cents.

This little book includes copies of all forms of consular invoices, with some useful hints as to drawing out bills of lading and other documents necessary in the shipping trade. As every shipper knows, or should know, attention to details is very essential, especially with regard to consular requirements imposed by various foreign countries, which often involves the perusal of lengthy documents. The author of this little book admirably sets out the gist of these in a concise and methodical form, which makes it an almost indispensable work to anyone engaged in export trade.

QUERIES AND ANSWERS.

Questions concerning marine engineering will be answered by the Editor in this column. Each communication must bear the name and address of the writer.

Q. 410.—It has frequently been asserted that United States battleships make their trial speeds on a very light displacement. Is this lighter in proportion than is the case in other navies? J. P.

A.—Each navy has a separate method of setting its requirements in this connection, but the general results are not very discordant. Figures which have been put into our possession, but which we cannot guarantee, show weights of the various items making up the displacement at normal load of the *Nebraska*, *Connecticut* and *Michigan* of the United States navy, and the *Dreadnought* of the British navy. The full-load displacements for the three American ships are also given, with an estimate for the *Dreadnought*, which will be discussed later:

	Connecticut		*Michigan*	
	Normal.	Full Load.	Normal.	Full Load.
Hull and fittings*	7,434	7,434	7,469	7,469
Armor	3,992	3,992	4,047	4,047
Battery and am'tion	1,339	1,536	1,118	1,300(a)
Machinery	1,500	1,500	1,577	1,577
Feed water	66	100	66	100
Coal	900	2,275	900	2 200
Equip't and stores†	769	829	823	924(a)
	16,000	17,666	16,000	17,617

	Nebraska		*Dreadnought*	
	Normal.	Full Load.	Normal.	Full Load.
Hull and fittings*	6,655	6,655	6,955	6,955
Armor	3,771	3,771	4,100	4,100
Battery and am'tion	1,213	1,417	2,930	2,930(b)
Mach'ry and water	1,830	1,830	2,190	2,190(b)
Coal	900	1,775	900	2,700
Equip't and stores†	579	646	825	825(b)
	14,948	16,094	17,900	19,700

The items marked (a) have been closely estimated. The items marked (b) have been here assumed to undergo no change between normal load and full load of the vessel.

* Includes protective deck.
† Includes officers, crew and effects.

This assumption is probably not correct. We have been informed by an English contemporary that with a complete outfit and full load on board, the *Dreadnought* was recently noticed drawing 31 feet 6 inches, in place of the legendary 26 feet 6 inches. The difference, assuming a coefficient of waterplane area of 0.75, would amount to about 4,200 tons in displacement, and would make the full-load displacement of the *Dreadnought* 22,100 tons. This is probably too high an estimate, and we are unable to verify it. On the other hand, it is a fact that the *Connecticut*, on starting from Hampton Roads for the Pacific, was very heavily laden with an immense amount of stores, etc., and unquestionably displaced more than the 17,666 tons with which she is credited at full load. The fact remains, however, that practice, as between the two navies mentioned, is not very different in actual working out, though it may appear to be on paper.

Some comment may be occasioned by the fact that the *Dreadnought's* battery appears disproportionately heavier than that of the *Michigan*, while the *Dreadnought* carries ten 12-inch guns to the *Michigan's* eight. This is due to the fact that it is British practice to include in such statements of weight of battery and ammunition the weight also of all armor protecting the battery. This includes the weight of turret armor and barbette armor. Under these headings are also included the motors and other auxiliary appliances for operating the turrets, guns and ammunition hoists, which in American practice are included under equipment. The item of armor in the *Dreadnought* includes merely vertical armor for the protection of the hull—the flotation and the stability. In the case of the American vessels this includes all armor of every description (except protective deck) as well as backing, bolts and cellulose.

Q. 414.—I have a motor boat 21 feet long, 5 feet 4 inches beam and weighing about 1,100 pounds. There is a two-cylinder two-cycle engine of 4½ horsepower, driving a 16-inch diameter propeller at 700 revolutions per minute. The area of blade is about 23.4 square inches. What is the proper pitch for a speed of 7½ to 8 miles per hour?

2.—What horsepower would be necessary to drive a 20-inch propeller to get speeds of 8 and 10 miles an hour respectively, with the same data as above?

3.—What is the pitch of a propeller, diameter 15½ inches and running 800 revolutions per minute with a 9-horsepower engine, to give 10 or 12 miles an hour with the above boat? R. J. N.

A.—There are two or three discordant features involved in these questions, but we will answer *seriatim* and discuss later.

On page 138 of Durand's "Motor Boats" is a formula for the pitch of a propeller to accompany a given speed and number of revolutions at an assumed slip. This formula is:

$$P = \frac{1{,}056\ V}{N\ (1 - s)}$$

where P is the pitch in inches; V is the speed in miles; N is the number of revolutions per minute; and s is the apparent slip of the propeller. Assuming in this case a slip of 22 percent and a speed of 8 miles per hour, we find the pitch figures out at 15½ inches.

2. On page 125 of the same book is a formula for powering motor boats, as follows:

$$H = \frac{A\ B}{K}$$

where A is a function of the weight of the boat (representing the two-thirds power of the number of thousands of pounds in this weight); B is the cube of the speed in miles per hour, and K is a coefficient used for designing and similar to the "Admiralty coefficient." In the first case mentioned, at 8 miles per hour, this coefficient figures out as 121, a very low result. If we use this same figure for the answer of the second question, we find that the horsepower figures out as 8.8 for a speed of 10 miles per hour.

3. Using the formula last above given, we find that for 12 miles per hour the Admiralty coefficient is 204, which ought

easily to be attained in a boat of this size. The pitch, figured on a basis of 12 miles per hour, and an apparent slip of 25 percent, is found to be $21\frac{1}{4}$ inches.

For a boat of this size with apparently speedy lines (the relation between weight, length and beam indicates this) it ought to be possible to reach a coefficient of upwards of 200 at 12 miles per hour, and probably no less than 350 at 8 miles per hour. In the latter case it would appear that the speed might be reached with under 2 horsepower, provided the propeller was properly suited to the engine. As to the different diameters of propellers, this in general would not affect the problem unless we reached so great a diameter as to expend a large part of the power in churning up the water (the pitch ratio in this case being small); or unless the diameter is so small that it is difficult to obtain sufficient blade area to prevent the occurrence of cavitation at high speeds. This would appear not to be reached in the present case, because, assuming two blades, we have a total of 46.8 square inches (apparently developed area), from which we may conclude that the projected area is in the neighborhood of 38 square inches. At 12 miles per hour and 9 horsepower, and a propulsive coefficient assumed at 48 percent, we find that the total thrust is about 135 pounds, which would give us a thrust per square inch of a little more than $3\frac{1}{2}$ pounds. Cavitation does not usually begin at a thrust of less than 11 pounds per square inch.

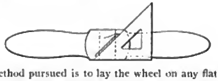
Q. 415.—If water filtered through alum, such as is used for city filtering plants, were fed occasionally to marine boilers, what would be the effect? J. F. W.

A.—If there is only a very small percentage of alum in the water, simply enough to coagulate the minerals in suspension, so that they precipitated promptly, and this is used in conjunction with one or two other chemicals, there would be no possible harm to the metal parts. If there is a strong solution of alum in the water at all times, however, it would not be suitable for a feed water.

The tendency of alum is to combine with scale-forming solids into an exceptionally hard mass. Scale consisting of calcium-sulphate, calcium-carbonate and magnesia becomes as hard as flint, and resists chemical reaction to a great extent. The whole thing hinges, therefore, on the percentage of alum in the water, and how often it is injected. P. B. B.

Q. 416.—What is the simplest method of obtaining the pitch of a propeller? R. A. W.

A.—A method which is simple and in quite general use consists merely in finding the distance from the center of the bore to that section of the blade which is at an angle of 45 degrees from the axis of the bore. This distance is the radius of a circle whose circumference is equal to the pitch, hence the pitch is easily figured.



The method pursued is to lay the wheel on any flat surface, with the axis perpendicular to this surface, and locate the required section of the blade with a 45-degree triangle. The distance from the axis may then be easily measured. Should the shaft be in the propeller, it may be laid down with the shaft parallel to the table, taking care that the center line of the blade is also parallel to the table, and the same course pursued.

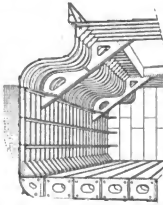
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

887,076. TURRET OR SIMILAR VESSEL. CHARLES D. DOXFORD, SUNDERLAND.

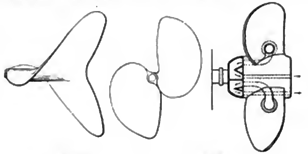
Claim.—In a turret vessel the combination of a hull, a turret forming



the upper part of the vessel and merging into the hull, deckbeams extending across the turret, a double bottom at the bottom of the hull, narrow internal frames extending from the deck beams to the double bottom, leaving an unobstructed space from side to side between the frames, large gusset plates extending from the frames to the deck at intervals in those portions of the vessel where the turret merges into the hull, and small knee plates securing the internal frames to the double bottom. One claim.

887,156. PROPELLER WHEEL. LOUIS J. H. VOSS, MENASHA, WIS.

Abstract.—The invention relates to improvements in propeller wheels, in which there are two similar blades, which commence at the forward end of the hub of the wheel with a small width, and widen out to the desired width, and make a twist along the hub of one-half of a circle, the working sides of the blades, when the boat to which it is applied is going forward, being concaved to a small degree. The objects of the improvement are to produce a wheel that is capable of producing great speed when compared with others of similar diameter and number of revolutions, and one that is adapted for running in shallow water where weeds abound. One claim.



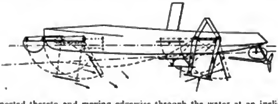
887,156. 887,486.

887,486. PROPELLING DEVICE FOR SHIPS. WILLIAM LOVIS, LONDON, E. C.

Claim 1.—A propelling device for ships comprising a boss or hub having blades, each of which has a perforation, a rotary hollow casing at the front of said propeller, and the chamber of which is divided into compartments, inlet passages connecting said perforations with said compartments, and exhaust passages from said compartments to the rear of said boss or hub. Three claims.

12,791. (REISSUE). MARINE NAVIGATION. SIDNEY A. REEVE, NEW HAVEN, CONN., ASSIGNOR TO WILLIAM M. AND LARNED E. MEACHAM, CHICAGO.

Claim 6.—In a water-conveyance, the combination with a body or vessel for receiving the passengers or load, of inclined supporting plates



connected thereto and moving edgewise through the water at an inclination to the longitudinal horizontal line, to give support to the body or vessel, and a propeller for imparting forward motion to the conveyance, said inclined supporting plates extending below the bottom of the body of the vessel, so that when the conveyance is in motion the body of the vessel may be supported entirely above the surface of the water. Thirteen claims.

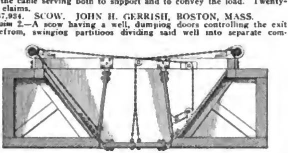
887,873. CABLE TRANSPORTER. JOHN R. TEMPERLEY, JOS. TEMPERLEY AND WILLIAM ALEXANDER, LONDON.

Abstract.—One end of the supporting cable is coiled on the drum of

the winding motor. The cable is passed through a dynamometer and led over a support at the end of the span, but not attached thereto, being left free to run over the support when hauled in or paid out. The cable is then led across the space to be spanned and attached to the support at the other end, or the cable may be carried around a sheave attached to the support and returned across the span and the end attached to a second winding motor, by means of which the cable may be hauled in or paid out, and this motion utilized for moving the carriage to and fro, the cable serving both to support and to convey the load. Twenty-five claims.

887,934. SCOW. JOHN H. GERRISH, BOSTON, MASS.

Claim 2.—A scow having a well, dumping doors controlling the exit therefrom, swinging partitions dividing said well into separate com-

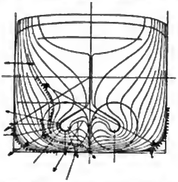


partments, chains for controlling said dumping doors and partitions, shafts located on different sides of said well with which said chains are adapted to make respective connection, and means whereby said shafts may separately be operated. Four claims.

British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

20,623. SHIPS' HULLS. E. COCKBURN, BREMERHAVEN, GERMANY.

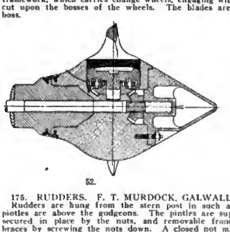
Relates to the form of the afterbody of the twin and triple-screw vessels, and particularly to the bossed frames for the stern tubes. The contour of the sections at about one-eighth of the length of the vessel from the after perpendicular is approximately the same as a



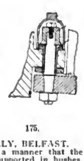
normal bilge at midships. Where the bossed frames run into the normal form of the vessel, the curve is made larger than usual, being, at about one-eleventh of the length of the vessel from aft, about the same as an inverted form of bilge amidships. The lines are preferably faired by diagonals through the center of the shafts. The bottom of the vessel is raised slightly towards the stern.

52. SCREW PROPELLERS. H. J. SPOONER, LONDON.

Relates to feathering propeller blades by means of epicyclic gearing, operated by a shaft within the hollow shaft of steam turbines. A bevel pinion fixed to a shaft engages with bevel wheels, which ride loosely on the tail pieces of blades. The bevel wheels are prevented from moving in the direction of the axis of the blades by means of a framework, which carries change wheels, engaging with the spur pinions cut upon the bosses of the wheels. The blades are screwed into the boss.



52.



175.

175. RUDDERS. F. T. MURDOCK, GALWALLY, BELFAST.

Rudders are hung from the stern post in such a manner that the pintles are above the gudgeons. The pintles are supported in bushes, secured in place by the nuts, and removable from above the stern braces by screwing the nuts down. A closed nut maintains the pintle in position, and the lower face acts in conjunction with the collar of the bush to form a bearing surface. A lock-nut is fitted to the closed nut. The stern post may be provided with an additional brace, having a pin and nut, which form with the nut an additional bearing surface for the rudder.

326. BINNACLE LAMPS. W. D. WHYTE, GLASGOW.

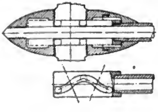
Relates to ships' compasses adapted to be lighted from below. The light, which is directed upwards by a suitable reflector, can be dimmed by rotating the reservoir, in connection with which is provided a combined reflector and obturator. A milled operating head is fitted. The lamp has grooves for attachment to slides at the side of the binnacle. The base is attached by bayonet-like catches, and has a handle.

454. SOUNDING APPARATUS. O. GUTT, BERLIN, GERMANY.

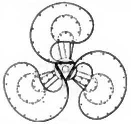
A drag for supporting a sounding instrument, or for a similar purpose, has a box-shaped body having open ends, and openings on all sides.

760. SCREW PROPELLERS. S. L. TAYLOR, FALMOUTH.

The blades of screw propellers are mounted in a hollow boss, and are provided at their inner ends with two pins by which they are reversed. The pins engage a curved slot in a sliding block, operated by a sleeve surrounding the shaft, or by a spindle passing through a hollow shaft. By using two pins, a turning couple is produced when the block is moved.



760.



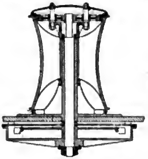
898.

898. SCREW PROPELLERS. D. JONES, CARDIFF.

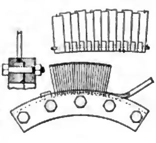
Relates to screw propellers in which the tips of the blades are continuous and do not overhang the shaft. The blade tips are riveted together, optionally over a bearing-block. The shape of this bearing-block varies with the number of blades used, each blade being built up of juxtaposed sheets. Each sheet constitutes the front surface of one blade and the back surface of the next. The boss in this case is part of a skeleton bracket, to which the roots of the blades are attached by arms. In similar propellers the blades are formed of twin sheets riveted to opposite sides of the flattened portions of arms, which are attached to the boss. The individual blades may, when developed, form a semi-annular or a half-ellipse with a smaller half-ellipse removed.

1,147. CAPSTANS, WINCHES, ETC. E. G. GOSSET-TANNER, AND R. T. DEANE, WESTMINSTER.

Capstans, winches, and like hauling mechanism are driven through reducing gear by a turbine, which is supplied with pressure liquid by means of a pump driven by an internal-combustion engine. A Pelton or like wheel is fixed on a vertical shaft, which is supported on a footstep bearing. The shaft rotates within a fixed sleeve, and carries at its upper end a pinion which gears with a series of pinions mounted on spindles, carried by the fixed sleeve and supporting a non-rotating cap. The pinions mesh with an internally-toothed ring secured to the inside of the capstan drum, which is supported on ball bearings. A band brake may be arranged to encircle the flanged portion of the drum.



1,147.



2,381.

2,381. TURBINES. C. A. PARSONS, AND J. W. WILSON, NEWCASTLE-ON-TYNE, AND J. FORD, WALLSEND.

Blades for turbines, turbine compressors, etc., are provided with interlocking means at their roots, so that they can be assembled and calked in a former in ring, segment, or strip form ready for application to the rotor groove. Blades and distance pieces have holes drilled in their centers, through which passes a solid rod or hollow tube. The blades and distance pieces are placed in a groove of a former, and by a suitable calking tool are driven up solidly and tightly, one or more at a time. The groove is slightly narrower than the rotor groove. One side of the groove consists of a removable flange, the width of the groove being determined by distance packing. The calking action causes the wire, blades, and distances pieces to bind together, but the assembled blades may be soldered or otherwise treated for additional security before insertion in the turbine groove.

A Curious Coincidence.—On page 370 of the August number appeared three British patents, all dealing with elastic fluid turbines, and emanating from Switzerland and Germany. The numbers are 27,940, 27,409 and 29,407. It will be noted that the five figures comprising each number are all the same, but differently arranged. The circumstance is, of course, purely accidental.

International Marine Engineering

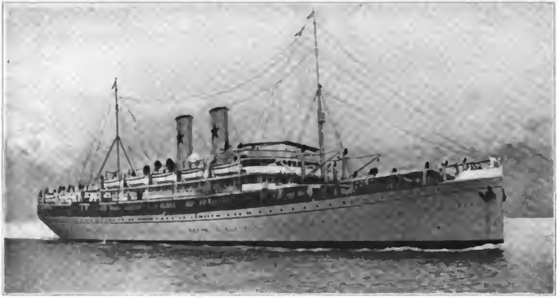
OCTOBER, 1908.

THE NEW ITALIAN STEAMSHIP EUROPA.

BY DAGNINO ATTILIO.

To the Veloce Company, of Genoa, a notable addition has again been made from the shipyard of Palermo in the *Europa*, constructed for the South American Line. She is a handsomely modeled ship, displacing 11,575 tons, of 430 feet in length, with a beam of 53 feet and a depth of 30 feet 10 inches, built under the special survey of the Registro Italiano and of Lloyds, to qualify for their highest class.

She is built of steel, with two complete steel decks, a cellular double bottom and poop, bridge and forecastle erections. The passenger accommodation throughout is very comfortable for 1,700 third class passengers and 74 first class.



THE NEW ITALIAN MAIL STEAMSHIP EUROPA, IN SERVICE TO SOUTH AMERICA.

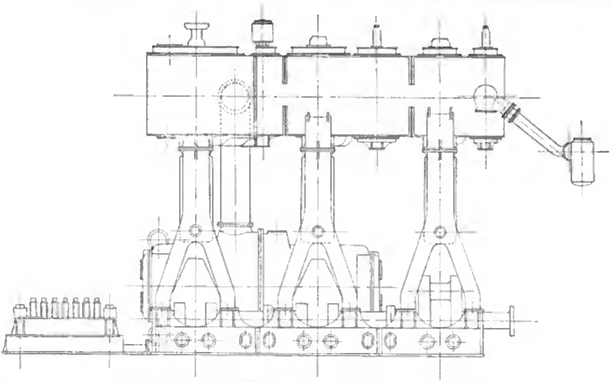
THE MACHINERY.

The propelling machinery was supplied from Gio Ansaldo, Armstrong & Company, Sampierdarena. There are two main engines of the three-cylinder, vertical, inverted, direct-acting, triple expansion type, balanced according to the Schlick system, and each capable of developing about 3,500 indicated horsepower at 90 revolutions per minute, and a steam pressure of 190 pounds per square inch. The sequence of cylinders, beginning forward, is: high-pressure, intermediate-pressure and low-pressure, with, respectively, 26, 42½ and 70⅞ inches diameter, and a common stroke of 51¼ inches. The cranks follow each other in the regular order of size of cylinders, the high-pressure being followed by the intermediate and low-pressure. On account of balancing, these cranks are at 120 degrees.

The high-pressure and the intermediate cylinders have each one piston valve, with diameters, respectively, 15¾ and 26¾ inches on the top and 15¼ and 26 inches on the bottom end. The low-pressure cylinder has a flat, double-ported slide valve. The valve stems are in all cases of a diameter of 4 5/16 inches, while the piston rods have each a diameter of 7⅛ inches. All valves are operated by Stephenson link motion from eccentrics, and can be worked by both steam and manual power. The valve strokes are 9 1/16 to 10 1/16 inches, respectively, for 0.66 and 0.74 cut-off. The length of the connecting rods is twice the cylinder stroke.

The main engines are in a single engine room without center line bulkhead, the starting platforms being conveniently located between the engines, with ample space for the engine crew to work in. The cylinders are safely bolted together, but there is no rigid fastening between them, thus allowing fore-and-aft play for expansion. Each of them is fitted with safety valves in the bottom and cover. They are supported by hollow cast-iron box columns, and these, in the neighborhood of the engine platforms, are utilized for oil storage, and provided with taps and pipes for filling them and for drawing off oil as needed. All stuffing box packings of the main engines, the piston rods and valve rods are metallic.

The main steam pipe has a diameter of 9 1/16 inches. The pipe carrying steam from high-pressure to the intermediate is 13⅜ inches, and the two pipes carrying steam from the intermediate to the low-pressure cylinder have each a diameter of 13¾ inches.



LONGITUDINAL ELEVATION OF EUROPA PROPELLING ENGINE, SHOWING CONDENSER IN BACK COLUMN.

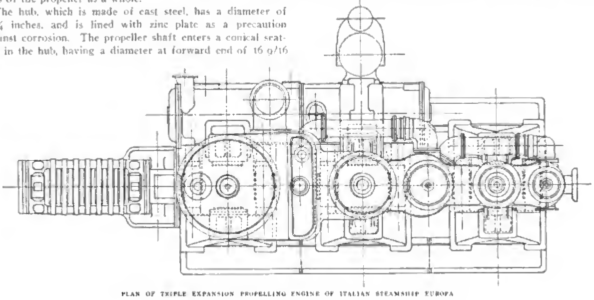
The shafting, which is made of best steel, has a tensile strength of 25.4 to 29.4 tons per square inch, and an elongation of 20 to 25 percent. The crank shaft diameter is 14 11/16 inches; thrust shaft, 14 11/16 inches; line shaft, 14 inches, and propeller shaft, 16 9/16 inches.

The two propellers, which are three-bladed, of the built-up type, turn outboard when going ahead. They are of manganese bronze and have a diameter of 16 feet 5 inches, and a pitch of 20 feet 7¾ inches at the periphery and 19 feet 8¼ inches at the boss. The mean pitch ratio is 1.23. The projected surface of each propeller is 67.97 square feet, the developed surface 84.17 square feet, and the ratio of projected area to disk area 0.314. The propeller blades are pitched aft, the axis of the blade at the tip being 12 inches aft of the axis of the propeller as a whole.

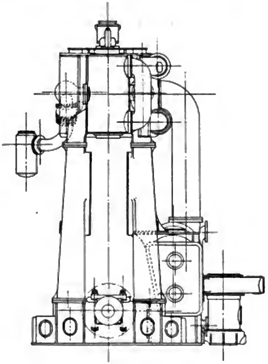
The hub, which is made of cast steel, has a diameter of 47¼ inches, and is lined with zinc plate as a precaution against corrosion. The propeller shaft enters a conical seating in the hub, having a diameter at forward end of 16 9/16 inches, and at the after end of 13¾ inches. This conical portion has a length of 3 feet 7 7/16 inches. A cap, covering the end of the shaft, protects the nut which holds the propeller in position. Each blade is fastened to the hub by means of nine studs.

THE BOILERS.

Four double-ended boilers of the cylindrical type, working at a pressure of 190 pounds per square inch, are located in one boiler room, and have two funnels. The furnaces have internal and maximum diameters of 3 feet 8¼ inches and 4 feet ¼ inch. The thickness is ⅝ inch. The grates are 6 feet 6¼ inches in length, the grate surface for each boiler being 145.3 square feet; while the heating surface in each boiler figures out at 4,359 square feet, or a ratio of 30 to 1,



PLAN OF TRIPLE EXPANSION PROPELLING ENGINE OF ITALIAN STEAMSHIP EUROPA



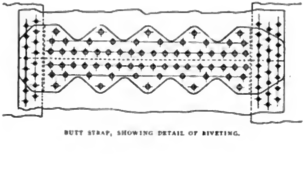
HIGH-PRESSURE END OF EUROPA ENGINE.

making for four boilers an aggregate grate surface of 581.2 square feet, and a total heating surface of 17,436 square feet.

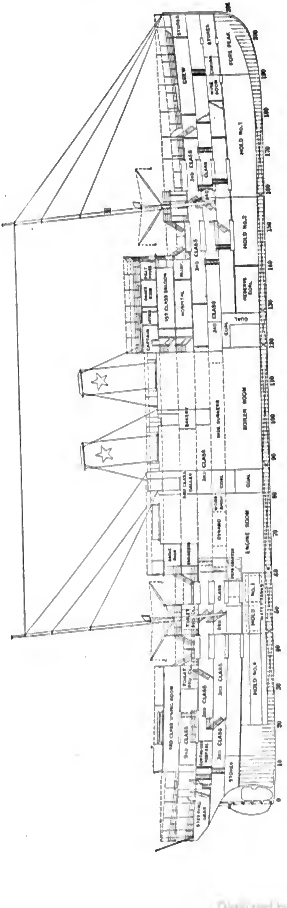
The boilers have a length over the ends of 18 feet 10¼ inches, and they are made in three courses, two being outside and one inside. The improvement in the longitudinal butt-strap seams is remarkable, they having only two rows of rivets running in the middle of the seams instead of four as are used in many other cases (see figure). The mean diameter is 14 feet 6½ inches, while the thickness of the plate is 1¼ inches.

Each boiler contains three Morison suspension furnaces in each end, with a separate combustion chamber for each pair of furnaces opposite each other. The length of tubes between tube sheets is 7 feet 5¾ inches, and they are placed 4 5/16 inches apart in each direction. Each end of boiler contains 298 tubes, of which 96 are stay-tubes and 202 are ordinary tubes. All have an outside diameter of 3¼ inches, with a thickness of 0.260 inch for the stay-tubes, and 0.164 inch for the others. The front tube sheets have a thickness of 29/32 inch, while the back tube sheets are 1 3/32 inches thick. The top of combustion chamber, ⅝ inch thick, is supported by the usual bridge girders, there being four on the central chamber and five on each of the side chambers.

The funnels, which have a crushed circular section, consist of an inner and outer tube, with sufficient air space between them; the area is 15 percent more than that of the boiler tubes.

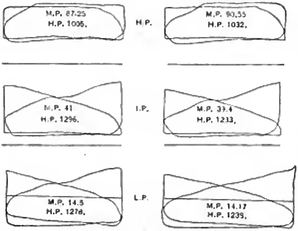


BUTT STRAP, SHOWING DETAIL OF RIVETING.



INBOARD PROFILE OF NEW ITALIAN EMIGRANT STEAMER EUROPA.

The indicator cards shown were taken on trial trip, with a boiler pressure of 197 pounds per square inch. The revolutions were: port, 89; starboard, 88. The vacuum: port, 26.5 inches; starboard, 26 inches. A total of 7,082 indicated horsepower was registered by the main engines.



INDICATOR CARDS FROM ENGINES OF EUROPA.

THE AUXILIARY MACHINERY.

The two main condensers have cooling surfaces amounting to 3,660 square feet each, while the auxiliary condenser has a cooling surface of 538 square feet. The cooling pipes are of brass, with a diameter of ¾ inch. The air pumps measure 25¼ inches in diameter, with a stroke of 25⅝ inches. The pump barrel is a bronze casting ¾ inch thick. Each main condenser is fitted with one circulating pump, operating at 160 revolutions per minute, of sufficient capacity to deliver the cooling water required for both engines when working with full steam.

Two feed pumps for each engine are fitted, to be used when needed for boiler feed; they consist in all their parts of bronze, and have a plunger of 3¾ inches diameter, the stroke being 25⅝ inches. There are fitted two single-acting bilge pumps and two pumps for sanitary purposes, of the same stroke as the feed pumps, and with 4 5/16 inches diameter. The barrel of the bilge pumps is cast iron and the plunger brass.

Besides these there are two evaporators, capable of giving 18 tons of fresh water in twenty-four hours. There are two Weir pumps, each with a capacity of 50 tons per hour, and two duplex steam pumps, which are each to draw drinking water, either from the tanks of the double bottom into a tank arranged in the engine room or directly into a tank on the promenade deck. In addition to these pumps there is a circulating pump for the auxiliary condenser, working at 180 revolutions.

The two starting engines have each two cylinders of 6 inches diameter, with a stroke of 6 inches. The turning engines have each one cylinder 6⅛ by 7½ inches.

The *Europa* is lighted throughout by electricity, and provided with a wireless telegraph equipment fitted in a room of the officers' house on the boat deck, telephones, a complete bell system, ventilating fans and a refrigerating plant.

The contract for constructing the three new United States naval colliers has been awarded to the Maryland Steel Company. The contract price is $479,000 (£98,427) for each. Work on the colliers will be started immediately, and they will be completed within a year.

MARINE ENGINE DESIGN.

BY EDWARD M. BRAGG, S. B.

CALCULATIONS FOR PISTON ROD, CROSS-HEAD AND SLIPPER.

Formula (20): $W = \dfrac{2 \times 1,000 \times 33,000}{850} = 77,700$ pounds.

Assume $C = 70,000$ pounds, $l = 42 + 23.5 + 4 = 69.5''$, (Use 70") $N = 15$.

Then $f = \dfrac{70,000}{15} = 4,670 \qquad F = \dfrac{2 \times 77,700}{3.142 \times 4,670} = 10.6$

Formula (21):

$$D^2 = \sqrt{\frac{0.48 \times 10.6 \times 70,000 \times (70)^2}{10,000,000} + (10.6)^2} + 10.6$$

$= \sqrt{174.5 + 112.5} + 10.6 = 16.9 + 10.6 = 27.5 \qquad D = 5.25$

Formula (23):

$$D' = \sqrt{\frac{40 \times 77,700}{3.142 \times 70,000}} + 0.325 = 4.085'', \text{ (Use 4'')}.$$

Allowing a shoulder of ⅛ inch at each end of the rod, and tapering at the rate of 3 inches per foot, the ends of the rod will be as shown in Fig. 26. Assume breadth of cross-head block $= 1.8 \times 5.25$ inch $= 9.45$ inches (use 9½ inches). Cross-head pins will be $5.25 \times 1.2 = 6.30$ inches (use 6¼ inches).

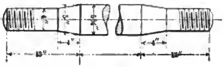


FIG. 26.

Assume allowable unit pressure on pins to be 1,000 pounds per square inch.

$$l \times d = \frac{77,700}{2 \times 1,000} = 38.85, \quad l = \frac{38.85}{6.25} = 6.22, \text{ (Use } 6\tfrac{1}{4}''\text{)}.$$

$$L = 9.5'' + 6.25'' = 15.75''.$$

The crosshead will be made of wrought steel, so that f can be

$\dfrac{60,000}{12} = 5,000$ pounds, $b = 9.5'' - \dfrac{4'' + 5''}{2} = 5''$. (See Fig. 23.)

Formula (24): $h = \sqrt{\dfrac{3 \times 77,700 \times 15.75}{2 \times 5.0 \times 5,000}} = 8.57''$, (Use 8¾").

Assume $\dfrac{r}{l} = \dfrac{1}{4.5}$; $G = \dfrac{77,700}{4.5} = 17,250$, P will be taken as 70 pounds.

The slipper is to be like Figure 18, made of cast steel,

$f = \dfrac{60,000}{12} = 5,000$ pounds.

Formula (25): $K \times L = \dfrac{77,700}{4.5 \times 70} = 246$ square inches.

Let $L = 13''$ and $K = 19''$.

Assume that the web joining the slipper to the block flange, and clearances, will take up 3 inches. The two backing surfaces will then be each 5 inches wide.

Unit pressure when backing $= \dfrac{17,250}{10 \times 19} = 91$ pounds

Formula (26): $t = \sqrt{\dfrac{77,700 \times 5 \times 6}{2 \times 4.5 \times 2 \times 19 \times 5,000}} = 1.167''$,

(Use $1\frac{1}{4}''$). Add $\frac{1}{8}$ inch white metal for each face.

Total thickness of slipper = $2\frac{1}{4}$ inches.

Backing guide to be of cast iron, stress = 1,500 pounds.

Formula (26):

$$t = \sqrt{\frac{77{,}700 \times 5 \times 6}{2 \times 4.5 \times 2 \times 19 \times 1{,}500}} = 2.13'', \text{ (Use } 2\tfrac{1}{8}'').$$

Assume backing guide bolts to be $1\frac{1}{4}$ inch diameter. Each guide carries a load of $\dfrac{77{,}700}{4.5 \times 2} = 8{,}633$ pounds.

$$e = \frac{5''}{2} + 0.5'' + \frac{1.25''}{2} = 3.625''; \; g = 1.25 \times 1.5 + 0.75 = 2.625'';$$

$$\frac{e + g}{g} = \frac{3.625 + 2.625}{2.625} = 2.38.$$

If bolts are spaced $7 \times 1.25'' = 8.75''$ apart, the number needed will be $\dfrac{42 + 19}{8.75} = 7$ (approximately). The load upon each bolt will be $\dfrac{8{,}650 \times 2.38}{7} = 2{,}945$ pounds. From Table IV., a bolt $1\frac{1}{4}$ inch in diameter can carry 3,520 pounds. Try $1\frac{1}{8}$-inch bolts.

$$\text{Spacing} = 7 \times 1.125'' = 7.875''; \; \frac{42 + 19}{7.875} = 8 \text{ (approximately)}.$$

$$e = \frac{5}{2} + 0.5 + \frac{1.125}{2} = 3.56''; \; g = 1.125 \times 1.5 + 0.75 = 2.43'';$$

$$\frac{3.56 + 2.43}{2.43} \times \frac{8{,}650}{8} = 2{,}670 \text{ pounds.}$$

From Table IV., a bolt $1\frac{1}{8}$ inch in diameter can carry 2,670 pounds; therefore, use $1\frac{1}{8}$-inch bolts.

Use four bolts for attaching slipper to crosshead block. $G = 17{,}250$ pounds; $\dfrac{17{,}250}{4} = 4{,}325$. From Table IV., bolts should be $1\frac{1}{8}$ inch diameter.

Engine calculations should be tabulated in some systematic way so that they can be readily compared one with another. Fig. 27 shows an abbreviation of the form used by the Bureau of Steam Engineering, United States navy, and when results are tabulated in this way, attempts to lighten construction can be made in an intelligent manner by progressively decreasing the factor of safety of different parts, as experience shows this to be permissible. It will be noticed, in the results given, that the factor of safety varies from 9 to 19 for the middle of the piston rod. It would not seem that the factor of safety need be as great as 19 if rods have worked satisfactorily with a factor of 12 or 15. The quantities J, R, and N, given in Fig. 27, are portions of equation (21) in a slightly different form. The factor of safety obtained from the expression

$$N = \frac{A \times C}{W \times R}$$

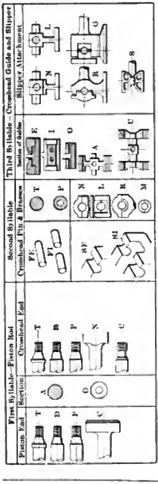


FIG. 27. DETAILS OF PISTON ROD, CROSSHEAD AND GUIDE.

Number.	Type.	Designed Load $W = \frac{2 \times \text{I.H.P.} \times 33{,}000}{P S}$	Diameter of Rod	Length of Rod l.	Radius of Gyration G.	$J = \frac{2l}{3G}$	Specified Ultimate Strength C.	Ratio Load at Middle to Steam Load $R = 1 + \frac{J^2C}{\pi^2E}$	$\frac{\text{Length Conn. Rod}}{\text{Crank}}$ $\frac{l}{r}$
1	Destroyer	76,000	$4\frac{1}{2}$–$2\frac{3}{4}$	$39\frac{1}{16}$	1.265	20.59	95,000	1.134	4.25
2	Torpedo boat	33,500	3–$1\frac{15}{16}$	$24\frac{1}{16}$	0.876	22.12	95,000	1.155	4.44
3	Gunboat	65,300	$4\frac{1}{2}$–2	$47\frac{1}{2}$	1.23	25.6	95,000	1.208	4.46
4	Revenue cutter	74,250	5	$50\frac{1}{4}$	1.25	26.85	80,000	1.192	5.
5	Battleship	295,000	8–$3\frac{3}{4}$	81	2.195	24.7	95,000	1.194	4.
6	Freighter	55,400	5	$66\frac{1}{2}$	1.25	35.5	70,000	1.241	4.57
7	Freighter	78,400	5	$74\frac{7}{16}$	1.5	33.1	60,000	1.219	4.5
8	Passenger boat	99,000	$5\frac{1}{4}$	$65\frac{3}{4}$	1.32	33.2	70,000	1.258	4.5
9	Passenger boat	78,500	$5\frac{3}{4}$	64	1.44	29.6	70,000	1.205	4.5
10	Atlantic liner	164,000	$7\frac{1}{2}$	82	1.88	29.1	70,000	1.198	4.44
11	Pacific liner	175,000	8	91	2.	30.3	80,000	1.245	4.42
12	Pacific liner	171,500	8	$104\frac{1}{4}$	2.	34.7	70,000	1.28	4.18
13	Atlantic liner	339,000	11	114	2.75	27.6	70,000	1.176	4

Number.	Description.	Factor of Safety $N = \frac{AC}{WR}$	Factor of Safety at Root of Thread. Piston End.	Factor of Safety at Root of Thread. Crank End.	Cotan Sec $\frac{l}{r} = \frac{H}{W}$	Load on Crosshead Guide H	Ahead. Dimensions of Slipper.	Ahead. Pressure per Square Inch.	Backing. Dimensions of Slipper.	Backing. Pressure per Square Inch.
1	TON-SEL-ER	9.05	8.8	7.65	0.242	18,400	11 x16	104	2x 3 x16	211.
2	TON-SEL-ER	11.4	10.4	11.6	.231	7,740	$7\frac{1}{2}$x$13\frac{1}{2}$	76.5	2x 2 x$13\frac{1}{2}$	143.
3	DON-SEL-EG	15.3	10.4	9.6	.23	15,200	12 x$14\frac{1}{2}$	87.5	2x $4\frac{3}{4}$x$14\frac{1}{2}$	106.
4	TAP-FIT-EN	17.8	10.8	10.8	.204	15,150	13 x16	73.	2x 5 x16	95.
5	TOC-FIP-EN	10.8	7.15	7.15	.258	76,200	23 x30	110	2x $8\frac{1}{2}$x30	149.
6	DAD-FIT-EN	18.2	12.2	12.2	.224	12,400	12 x19	54.5	2x $4\frac{1}{2}$x19	73.
7	DAD-FIT-EN	17.75	11.8	11.8	.228	17,900	14 x$22\frac{1}{2}$	57.	2x $4\frac{1}{2}$x$22\frac{1}{2}$	89.
8	TAD-FIT-AN	12.2	10.9	10.9	.226	22,600	12 x24	78.2	12 x24	78.2
9	DAD-FIT-EN	19.2	15.3	15.3	.228	17,900	16 x24	46.6	2x 6 x16	99.4
10	CAD-FIT-EN	15.8	12.7	12.7	.231	37,900	$22\frac{1}{2}$x30	56.1	2x $8\frac{1}{2}$x30	75.2
11	TAP-FIT-EN	18.5	11.5	11.5	.232	40,650	24 x30	56.5	2x 8 x30	85.
12	TAD-FIT-US	16	10.3	10.3	.246	42,200	2x28x11	68.5	2x28 x11	68.5
13	TAD-FIT-US	16.7	11.3	11.3	.258	87,700	2x20x47	46.7	2x20 x47	46.7

should be the same as the factor of safety N used in equation 21. In the expression for R, π^2 is assumed to be 10, and E is assumed to be 30,000,000.

Connecting Rod.—The body of the connecting rod is figured

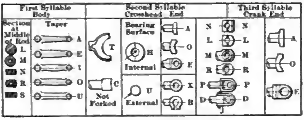


FIG. 28.—CONNECTING ROD DETAILS.

Number.	Type.	Description.	Length of Rod, Center to Center, L.	$\frac{L}{r}$.	Coeff. See— $1 - \frac{L}{r} = K$.	Load on Rod $= Wk = P$.	Specified Ultimate Strength, C.	Ratio Load at Middle to Load at Ends $= R = 1 + \frac{L^2C}{G^2\pi^2E}$
21	Destroyer	MA-TUX-MO.	46½	4.25	1.03	78,200	95,000	1.480
22	Torpedo boat	SAI-TUX-LA	40	4.44	1.027	34,400	95,000	1.307
23	Gunboat	MA-TUX-NA	67	4.465	1.026	67,000	95,000	1.957
24	Revenue cutter	LA-THAN-NA	75	5.	1.021	75,800	80,000	1.761
25	Battleship	MA-THAN-NA	96	4.	1.032	304,200	95,000	1.495
26	Towboat	LA-THAL-LA	65	5.	1.021	37,300	65,000	1.88
27	River boat	LA-TUX-NA	68	4.535	1.026	42,200	95,000	1.845
28	Freighter	LA-THAN-LA	94½	4.5	1.026	72,700	60,000	1.649
29	Passenger boat	LA-THAN-NA	94½	4.5	1.026	90,500	70,000	2.02
30	Atlantic liner	LA-THAN-NA	120	4.45	1.027	148,000	70,000	1.85
31	Pacific liner	LA-THAN-LA	138	4.18	1.031	176,800	70,000	2.

Number.	Smallest Section of Rod.				Section at Middle of Rod.					
	Dimensions.	Shape.	Area.	Factor of Safety.	Dimensions.	Shape.	Area A.	Radius of Gyration G.	$\frac{L}{G}$.	Factor of Safety at Middle of Rod $= N = \frac{AC}{PR}$
21	3½-2½	M	7.817	9.5	4.2-2½	M	9.878	1.19	39.3	8.87
22	4.06x1½	S	5.063	13.9	4.45x2	S	8.9	1.285	31.1	18.8
23	4½-2	M	11.05	15.7	4.44-2	M	12.36	1.218	55	8.95
24	5	L	19.64	20.8	5.62	L	24.8	1.405	53.3	14.9
25	7½-5	M	27.34	8.6	8½-5	M	35.43	2.44	39.3	7.4
26	3¾	L	11.04	19.2	4.09	L	13.13	1.02	63.75	12.2
27	4	L	12.57	19.3	4.35	L	14.97	1.09	62.4	12.5
28	6½	L	30.68	25.4	6.64	L	34.55	1.66	57.	17.3
29	5	L	19.64	15.3	5½	L	26	1.44	65.6	10
30	7½	L	41.4	19.6	8	L	50.2	2	60	12.8
31	7½	L	44.18	17.5	8½	L	56.75	2.125	65	11.22

as a column hinged at both ends, and the formulæ have the same form as those for the piston rod, except that the constant is 1.08 instead of 0.48, and the factor of safety used is different. The middle portion of the rod is usually made tapered, and the formulæ give the diameter at the middle of the rod.

Solid rod:

$$D^2 = \sqrt{\frac{1.08 \times F \times C \times l}{10,000,000} + F^2} + F. \qquad (27)$$

Hollow rod:

$$D^2 = \sqrt{\frac{1.08 \times F \times C \times l}{10,000,000} + F^2 + (2F + d^2)d^2} + F. \qquad (28)$$

$F = \frac{2P}{\pi f}$; P = load upon connecting rod $= W \times k$; W = load on piston rod; l = length of connecting rod $= h \times$ stroke; h varies from 2 to 2½:

When $h =$ 2	2.125	2.25	2.375	2.5
$k =$ 1.033	1.03	1.026	1.023	1.021

f = allowable stress on rod, $= \frac{C}{N}$;

C = ultimate strength of material,
= 60,000 to 70,000 pounds for merchant engines,
= 80,000 to 95,000 pounds for naval engines;

N = factor of safety,
= 8 to 10 for naval engines,
= 12 for merchant engines;

d = inside diameter of rod, and is usually from

$$\tfrac{1}{2}\sqrt{2F} \text{ to } \tfrac{3}{4}\sqrt{2F}.$$

The increase of the stress at the middle of the rod, due to the tendency of the rod to spring when being compressed, is generally about 75 percent (see column marked R, Fig. 28), so that theoretically the area at the very top of the column could be 57 percent of that at the middle and have no greater stress. The fork of the rod takes up about one-fourth of its length, so that the area at the smallest section should be about 80 percent of the area at the middle. In order that the area may be 80 percent, the diameter must be 90 percent. Due to the swinging of the rod across the line of the dead centers, and its being brought to rest on either side of the crank pin, there is bending introduced near the crank-pin box from the inertia of the rod. This additional bending is seldom figured, but the diameter here is increased as much as the diameter at the upper end is decreased, so that the rod has a uniform taper from end to end. The diameter at G, Fig. 29, should be 0.9 H, and the diameter at I should be 1.1 H.

The distance Z between the flat faces of the fork is made equal to G, or slightly greater. The heads of the cap bolts of the boxes of the fork must clear these faces by about ⅛ inch, and the diameter of the cross-head pin should be such that it clears the body of these bolts by about ¼ or ⅜ inch. It may be necessary to change the diameter of the cross-head pin after finding the diameter of these bolts, in order that there may be not too much nor too little clearance here.

The four bolts at the cross-head end, and the two at the crank-pin end, of the rod should be designed to carry the load P, and their diameters can be taken from Table IV. The nuts for the bolts are usually of the collar type, shown in Fig. 5 and Table V. The boxes at the forked end are made with E greater than K (see Fig. 29); the amount of the overhang to be allowed in any case being determined by comparison with a similar rod in the table accompanying Fig. 29. F should be taken from the computation for the cross-head block, allowance being made for the facing strip and a slight clearance, 1/32 inch or less. $W' = F + E - K$, E being equal to the length of the cross-head pin. V should be taken from the details of the cross-head block, the bottom of the fork clearing the end of the piston rod nut by about the thickness of the nut. The thickness Q should be from ¼ to ½ inch greater than X.

The thickness S of the caps is determined by considering the cap as a beam of breadth K, supported at the ends by the cap bolts; so that the span is T. As the load is distributed over a part of the beam, the bending moment is generally obtained from the formula

$$M = \frac{W \times l}{6}, \text{ where } l = T, \text{ and } W = \frac{P}{2}; \text{ thus } M = \frac{P \times T}{2 \times 6};$$

$$I = \frac{K \times S^3}{12}; f = \frac{M \times y}{I} = \frac{P \times T}{2K \times S^2};$$

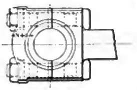


FIG. 29.

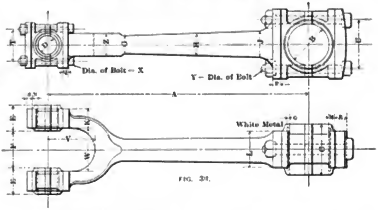


FIG. 30.

CONNECTING ROD AND DETAILS.

No.	A / Crank.	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	4.8	72"	9"	8¾"	4½"	4½"	7"	3¾"	4⅛"	4½"	3¾"	7"	1⅜"	1"	⅞"	3"	2¼"	3"	2¼"	6¾"	12⅜	10	8	1⅜	2½	3⅜"
2	5.	60	9	10⅝	4½	4½	7½	3⅝	4 3/16	4½	3⅝	8	1⅝	....	⅞	3	2	2⅜	N + S 2⅝	6⅝	12⅜	11	9	1⅜	2½	3⅝
3	....	54	10½	9⅝	5	5⅜	7⅝	4	4⅜	4⅝	4⅝	7½	1½	⅝	⅝	3⅝	2⅜	3⅝	2⅜	7½	14	11	8⅝	2	2⅜	4⅝
4	....	60	9	9	4½	5	7½	4	4½	5	4	6⅝	1⅝	....	....	3⅝	2½	2⅝	N + S 2¼	7⅝	12¼	10	8½	2	2⅝	4
5	4.5	81	12⅝	15	7⅝	8½	10½	5⅝	6	6½	6½	10½	2⅜	1½	⅞	4	3⅝	..	..	..	..	..	..	3⅜	4	..
6	4.	84	15	16⅜	7½	9	13	6⅝	7½	8½	7½	12	2⅝	1½	⅞	...	3½	4½	N + S 4	11½	20½	12½	15½	3	4⅜	6⅜
7	4.18	138	20½	18⅜	10½	9⅞	11⅜	7½	8½	9⅜	7⅜	13½	2⅜	1¼	1	5½	4	R + M 5½	4½	14⅜	26½	20¼	13⅜	3⅜	5	8

then

$$S = \sqrt{\frac{P \times T}{2 \times K \times f}}. \qquad (29)$$

Where P = load upon connecting rod;
T = distance between center lines of cap bolts;
K = breadth of cap;
f = allowable stress.

The load upon the caps is intermittent in character, so that the factor of safety should be 8. The caps are usually made of bronze, cast steel or wrought steel. The thickness N of the brasses can be taken from the table of Fig. 29. The thickness of the metal of the caps, where they inclose the bolts, is generally about $\frac{X}{4}$. Between the upper and lower brasses there is one thick cast iron liner, usually from 1 inch to 1¼ inches in thickness, held in by dowel pins and several thin tin liners varying from 1/16 to 1/64 inch.

The fork of the connecting rod is figured as if the ends were free to move. The force $\frac{P}{2}$, considered as acting at the middle of the length of the box, will cause bending, direct compression and shear upon a given section of the fork. It is usual to consider only the bending, and to allow for the direct compression and shear by using a low stress. The design can be simplified by proceeding as in Fig. 31. The inside of the fork is semi-circular in shape, the semi-circle at its lowest point being a distance V from the center line of the cross-head pins, and the radius of the semi-circle being equal to $\frac{W}{2}$, see Fig. 29.

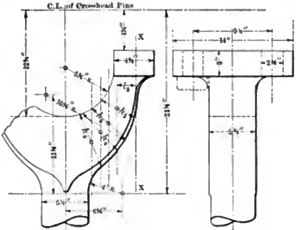


FIG. 31.

To get the outline of the outside of the fork, draw a number of lines a distance l apart, parallel to X X, which passes through the center of the length of the bearing. Certain sections of the fork lying about normal to its outside edge will have their neutral axes upon these lines. The breadth of the sections will be Z (see Fig. 29), and the length must be sufficient to cause the stress upon them to be within the desired limits. The bending moment upon the section l_1" distant from X X will be $\frac{P \times l_1}{2}$. If h is the length of the section, then

$$f = \frac{P \times l_1 \times h_1 \times 12}{2 \times 2 \times Z \times h^3} = \frac{3Pl_1}{Z \times h^2}$$

or,

$$h_1^2 = \frac{3 \times P \times l_1}{Z \times f}. \qquad (30)$$

Since, for the other sections, everything else is the same except the distance l_1, and since

$$l_2 = 2l_1, \quad l_3 = 3l_1, \quad l_4 = 4l_1, \text{ etc.,}$$

then

$$h_2^2 = 2h_1^2, \; h_3^2 = 3h_1^2, \; h_4^2 = 4h_1^2, \text{ etc.}$$

The distances h_1, h_2, h_3, etc., can be laid off about normal to the semi-circle, so that their centers fall on the lines distant l_1", l_2", l_3", etc., from X X. Through the ends of these lines the edge of the other side of the fork can be drawn. The curves should be arcs of circles, for the sake of convenience. Sometimes the construction of the piece is simplified by substituting a straight line for the curve. In this case the line must pass outside of all the points laid off, and for this reason will give a heavier fork than before.

The crank-pin end of the rod cannot be completed until the size of the crank pin is determined, and this depends upon the size of the crank shaft. When the size of the crank shaft has been determined, and from that the size of the crank pin, the length C (see Fig. 29) of the box should be such that the bearing pressure per square inch does not exceed that given in Table VII. The load upon the crank pin is the resultant of the thrust through the rod, due to the steam pressure on the piston, the inertia and weight of the reciprocating parts, and the centrifugal force of the crank-pin end of the connecting rod. The following formula gives the approximate mean load upon the crank pin;

$$L = 1.6 \times \frac{21{,}000}{P.\ S.} \times I.\ H.\ P., \qquad (31)$$

where $I.\ H.\ P.$ = the indicated horsepower of the cylinder over the pin;

$P.\ S.$ = the piston speed of the engine in feet per minute.

The factor, 1.6, may vary from 1.4 to 1.8, depending upon the distribution of power among the cylinders, as there would be considerable bearing pressure upon the pin, due to the inertia of the reciprocating parts and the centrifugal force of the end of the connecting rod, even if there were very little power being developed in the cylinder. The factor 1.6 is for average conditions, and should be increased if the cylinder develops less than its share of the power, and decreased if more is developed.

The cap of the crank-pin end is designed to carry the total load P, so that the formula for the thickness R becomes

$$R = \sqrt{\frac{PU}{Lf}}, \qquad (32)$$

where P = load upon connecting rod (by Formula 20);

U = distance between center lines of bolts;

L = breadth of cap;

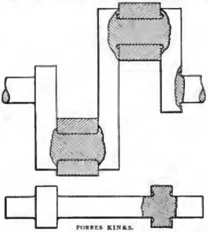
f = stress to give a factor of safety of 8.

The bolts, brasses, etc., are obtained in the same way as for the forked end of the rod. The two parts of the box are separated by liners, a cast iron liner whose thickness varies from 2½ to 4½ inches, and thinner brass and tin liners. The cap may be of wrought steel, cast steel or bronze. When made of cast steel or bronze the shape is generally that shown in Fig. 30. The bolts should clear the crank pin by an amount varying from ⅛ inch to ⅝ inch.

(*To be continued.*)

Fillets on Shafting.

High-speed engines are among the regular products of the shop of W. D. Forbes & Co., Hoboken, N. J., these going largely into naval and other marine service for lighting. This means careful attention to bearings, as they run in warm places and space is limited. Mr. Forbes has made a departure from the usual method of putting in fillets, which is giving good results. In both the crankshaft and the shaft with



FORBES KINKS.

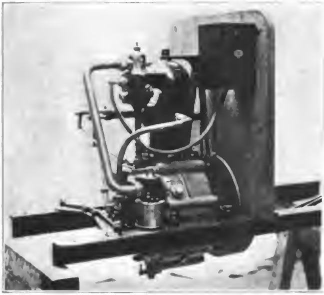
shoulders, those at the left are of the usual kind. This reduces the length of the bearing somewhat, as only the straight portion can be used for this purpose. It is further objected that, if the bearing heats, it tends to ride up on the fillets, reduce the bearing on the crankpin, and so increase the heating.

The plan used here is shown at the right. The fillet is cut in the crank face or in the collars of the shaft. This does away with the sharp corner as effectively as the other method, and has worked out well in their practice.—*American Machinist.*

The Petrol Launch Dion Bouton.

This little vessel has been equipped by the De Dion Bouton Automobile Company, Ltd., with an 8-horsepower engine, having a single cylinder 3¾ inches in diameter by 3¾ inches stroke, and operating at 900 revolutions per minute. The boat has a length of 25 feet and a beam of 5 feet 6 inches. The engine is under the after end of the hood covering the forward end of the cockpit, and is thus located about amidships. The speed of the boat is 9 miles per hour.

THE MOTOR LAUNCH DION BOUTON, FITTED WITH AN 8-HORSEPOWER ENGINE.



EIGHT-HORSEPOWER ENGINE OF LAUNCH DION BOUTON.

The Naval Strength of the Nations.*

BY SIDNEY GRAVES KOON.

As has been the case continuously for nearly 200 years, Great Britain occupies the premier naval position at the present time, with 193 ships of upward of 1,000 tons each, active and building, as compared with 117 for Germany, 110 for the United States, and 96 for France. The list following tabulates the situation at the moment for the leading eight powers, with the results of such combinations as the Anglo-Saxon, the Franco-Russian, the Dreibund (Germany, Italy and Austria), and the sum of the two latter:

	Ships.	Displacement. Tons.	Guns.	Average Tons.	Average Knots.	Ships over 10,000 Tons.	Ships over 16,000 Tons.
Great Britain	193	1,897,860	7,540	9,833	20.15	103	20
United States	110	837,208	3,955	7,611	18.97	41	12
France	96	788,573	3,235	8,048	19.09	37	6
Germany	117	780,720	3,844	6,673	19.1	33	9
Japan	48	422,70[illegible]	1,829	8,806	19.97	18	4
Russia	50	339,689	1,747	6,794	18.38	13	2
Italy	43	321,872	1,081	7,485	20.16	13	1
Austria	27	171,991	866	6,370	19.67	6	..
All others	155	558,285	3,550	3,580	17.9	3	3
Totals	840	6,118,907	28,247	7,284	19.44	267	57
Anglo-Saxon	303	2,735,068	11,495	9,027	19.79	144	32
Franco-Russian	146	1,128,262	4,982	7,727	18.87	50	8
Dreibund	187	1,274,583	6,391	6,816	19.44	52	10
Continental	333	2,402,845	11,373	7,216	19.18	102	18

Such figures as these do not tell the whole story. For instance, the fastest navy is that of Chile, with an average speed of 20.74 knots. Brazil comes next, with 20.18 knots, followed closely by Italy and Great Britain, while Argentina, with 18.88 knots, is ahead of Russia; otherwise the order may be picked from the table. In average size of ships no nation not in the table has an average as great as has Austria, the lowest listed. The only ships of over 10,000 tons belonging to any nation outside the eight tabulated are three battleships building for Brazil in England and said in some quarters to be ultimately destined for Japan.

An examination of the table shows that the Anglo-Saxon combination is superior to the five combined continental nations in displacement, guns, average size and speed, and much superior in the number of large ships. In total number of ships only are we inferior. Of course, the large advantages accruing from a common language and common ideals would be of enormous benefit should it ever be necessary to measure strengths.

Taking up the eight leading nations in a little more detail, and omitting further all ships under 3,000 tons and all unarmored ships under 18 knots, we get two tables, one covering battleships only, while the second covers cruisers, both armored and protected. In each case the divisions are somewhat arbitrary, but they are thoroughly uniform, and totally fair.

	BATTLESHIPS.								
	FIRST CLASS.			SECOND CLASS.			COAST DEFENSE.		
	Ships.	Tons.	Speed.	Ships.	Tons.	Speed.	Ships.	Tons.	Speed.
Great Britain	56	862,000	19.08	14	152,070	17.29	2†	18,660	14.43
United States	31	445,679	18.54	..	......	....	11	45,339	12.83
France	22	313,956	18.66	8	84,262	15.98	10	66,789	15.33
Germany	20	314,290	19.63	14	152,581	17.61	13	66,634	14.98
Japan	15	231,752	19.8	3	36,308	18.04	3	18,126	14.91
Russia	8	112,134	17.71	4	37,753	16.47	5	32,923	14.7
Italy	10	135,828	21.04	5	62,317	17.74	..	......	....
Austria	3	43,500	20.	6	55,923	20.15	5	28,549	17.02

† Lately condemned and about to be sold.

	CRUISERS.								
	ARMORED.			FIRST CLASS.			SECOND CLASS.		
	Ships.	Tons.	Speed.	Ships.	Tons.	Speed.	Ships.	Tons.	Speed.
Great Britain	35	417,360	23.01	23	213,710	20.75	39	176,220	20.11
United States	15	186,651	22.19	3	20,620	22.58	12	47,117	21.27
France	18	190,796	22.07	4	29,655	22.14	16	80,230	19.33
Germany	8	78,381	21.15	..	......	....	27	107,996	21.84
Japan	9	81,412	21.53	1	6,500	23.7	8	33,931	21.49
Russia	6	62,644	20.67	6	38,935	23.14	6	32,100	19.46
Italy	7	61,250	21.61	1	6,000	25.	3	17,203	19.44
Austria	1	7,185	22.01		......	....	5	22,804	20.68

These two tables should be supplemented by another giving the totals, the total battleships and the total armored fleets, as follows:

	GRAND TOTALS.			TOTAL ARMORED.			TOTAL BATTLESHIPS.		
	Ships.	Tons.	Speed.	Ships.	Tons.	Speed.	Ships.	Tons.	Speed.
Great Britain	169	1,840,120	20.06	107	1,450,090	19.95	72	1,032,730	18.73
United States	72	745,408	19.39	57	677,669	19.16	42	491,018	18.01
France	78	765,788	19.12	58	655,903	18.97	40	465,107	17.7
Germany	82	719,882	19.27	55	611,886	18.81	47	533,505	18.47
Japan	39	408,029	19.98	30	367,598	19.77	21	286,186	19.33
Russia	35	316,489	18.68	23	245,454	17.87	17	182,810	16.91
Italy	26	282,398	20.39	22	259,095	20.37	15	197,845	20.
Austria	20	157,961	19.71	15	135,157	19.55	14	127,972	19.4

One further table will conclude our study of the question. This deals with the batteries of the various ships, arranged

	12-inch Guns.		8 to 12-inch Guns.		3.9 to 8-inch Guns.		Smaller.
Great Britain	312	(298)	172	(134)	1,915	(1,047)	4,701
United States	172	(172)	224	(162)	728	(374)	2,230
France	103	(100)	108	(62)	859	(472)	1,870
Germany	...	...	326	(299)	741	(371)	2,187
Japan	66	(66)	126	(89)	428	(218)	1,080
Russia	50	(46)	83	(53)	379	(204)	1,035
Italy	44	(44)	97	(69)	310	(161)	788
Austria	17	(15)	63	(51)	210	(108)	448

*The Iron Age.

according to the size of gun. The first column shows the number of guns of 12-inch caliber and upward carried on the ships listed, with the broadside fire in parenthesis. The second column shows the guns of 8-inch and upward, but under 12-inch; the third shows those between 3.9-inch (10 cm.) and 8-inch, while the last shows the smaller guns and torpedo tubes.

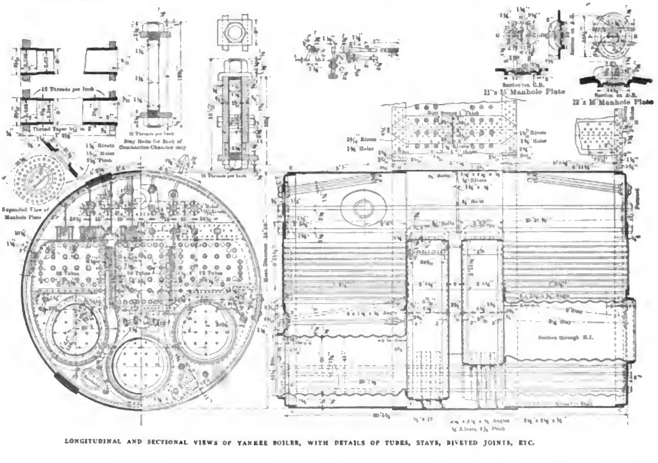
It will be noted that, with regard to number and aggregate displacement of fighting ships, the United States, France and Germany are running a very close race, standing in that order in armored ships, but with little room for choice. When we examine the batteries carried, however, the immense superiority of the United States in heavy guns, and particularly in 12-inch guns, becomes at once apparent. Germany has no guns over 11 inches. In those of 8 inches and upward the United States carries 396, to 326 for Germany (averaging smaller in size) and 211 for France. It will be remembered that in the war of 1812 a large part of the American success at sea was attributed, and rightly, to the American guns and the way they were handled. The United States has to-day a navy with heavier guns on the average than those carried by the ships of any other power, not even excepting England, and reports of target practice leave little doubt that their gunnery is without an equal on the face of the globe.

BOILERS FOR THE U. S. S. YANKEE.*

It may not seem to be a very unusual or remarkable accomplishment to the boiler makers in a large, modern, up-to-date contract shop to build three double-ended boilers each 13 feet 10 inches diameter and 20 feet long, with six furnaces and separate combustion chambers, but to carry out this work successfully and rapidly in a navy yard, where the equipment of the boiler shop is suitable only for repair work and small jobs, is a feat worth noting. The boilers for the United States ship *Yankee*, photographs and drawings of which are shown herewith, were built at the Charlestown (Mass.) Navy Yard, under the supervision of Mr. J. R. Truckses, master boiler maker. In this yard the boiler shop is small, and as yet has not been equipped with modern machinery and cranes for handling large and heavy jobs of boiler construction. An endeavor is now being made, however, by the head of the Department of Steam Engineering, Commander George E. Bird, U. S. N., to secure an appropriation for the enlargement of the boiler shop at this yard and the installation of electric cranes and more modern machinery. Certainly the work done at this yard with the available facilities speaks well for the ability and ingenuity of the master boiler maker, and should be a good argument to be used by the chief engineer in his request for an appropriation from Congress to modernize this plant.

The boilers of the *Yankee* are the largest ever constructed in a government navy yard, and have been the source of considerable favorable comment from outside manufacturers who have been fortunate enough to witness their construction. The boilers are 13 feet 10 inches mean diameter by 20 feet 1¾ inches long outside the heads. They are to be operated at a steam pressure of 170 pounds per square inch, and will weigh when completed 68 tons each. Each boiler has six corrugated furnaces with separate combustion chambers and 504 3-inch tubes. The grates are each 6 feet 10 inches long by 3 feet 4½ inches wide, making a total grate area of 138 square feet. There is a total heating surface in each boiler of 3526.97 square feet, divided as follows: Heating surface of tubes, 2840.98 square feet; heating surface of furnaces, 242.25 square feet; heating surface of combustion chambers, 443.74 square

* *The Boiler Maker.*



LONGITUDINAL AND SECTIONAL VIEWS OF YANKEE BOILER, WITH DETAILS OF TUBES, STAYS, RIVETED JOINTS, ETC.

SIDE VIEW OF THE BOILER, SHOWING DETAILS OF RIVETING.

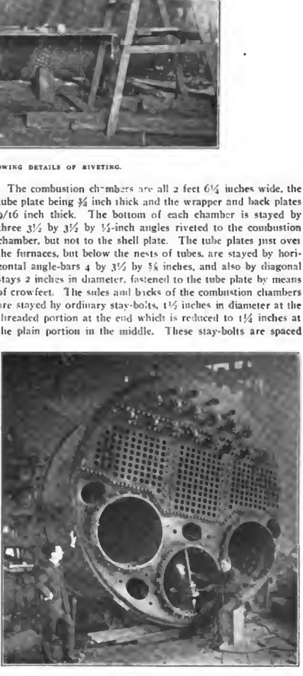
feet. The ratio of heating surface to grate area is therefore 25.55. The area over the bridge wall is 3.11 square feet, and its ratio to the grate area 1 to 7.42.

The shell of the boiler is constructed of three courses of three plates each, the middle course being the outside course. The plate is open-hearth mild steel of 60,000 pounds tensile strength 1¼ inches thick. The longitudinal seams of the shell are triple riveted butt joints, the butt straps being of plate 1 inch thick, fastened with 1¼-inch rivets in 1 5/16-inch holes, pitched 8 1/16 inches between centers. The inner rows are 2 5/16 inches apart and the outer ones 3 5/16 inches. The percentage strength of plate at the joint is 83.72, and the percentage strength of rivets 93.27. All rivets in the boiler are of mild steel of 58,000 pounds per square inch tensile strength and about 48,000 pounds per square inch shearing strength. The girth seams of the shell are triple riveted lap joints, fastened with 1 5/16-inch rivets in 1⅜-inch holes, spaced 4⅛ inches between centers. The percentage strength of plate at these joints is 66.66, and of the rivets 68.6.

The boiler heads are all flanged inwards and joined to the shell with double riveted lap seams fastened by 1¼-inch rivets in 1 5/16-inch holes, spaced 3½ inches between centers. The percentage strength of the plate in the joint is 62.5, and the percentage strength of the rivets 70.15. Each head is in three sections, the tube plate, which is ¾ inch thick, the furnace plate 1⅛ inch thick and the upper portion, which is in the steam space of the boiler, also 1⅛ inches thick. The upper plate is joined to the tube plate with a triple riveted lap joint, fastened by 1¼-inch rivets in 1 5/16-inch holes, spaced 3½ inches between centers, the percentage strength of the plate being 62.5, and of the rivets 70.15. The tube plate is joined to the furnace plate by a single riveted lap joint fastened with 1 3/16-inch rivets in 1¼-inch holes, spaced 2⅝ inches between centers, the percentage strength of the plate being 52.3 and of the rivets 51.6. The furnace holes are all flanged outward, and, of course, the manhole openings are flanged inwards.

The corrugated furnaces are each 7 feet 8 3/16 inches long and 43 inches outside diameter. The inside diameter is 39 inches, and the thickness of the plate ½ inch.

The combustion chambers are all 2 feet 6¼ inches wide, the tube plate being ¾ inch thick and the wrapper and back plates 9/16 inch thick. The bottom of each chamber is stayed by three 3½ by 3½ by ½-inch angles riveted to the combustion chamber, but not to the shell plate. The tube plates just over the furnaces, but below the nests of tubes, are stayed by horizontal angle-bars 4 by 3½ by ⅝ inches, and also by diagonal stays 2 inches in diameter, fastened to the tube plate by means of crowfeet. The sides and backs of the combustion chambers are stayed by ordinary stay-bolts, 1½ inches in diameter at the threaded portion at the end which is reduced to 1¼ inches at the plain portion in the middle. These stay-bolts are spaced



END VIEW OF THE BOILER, SHOWING METHOD OF DRILLING.

6½ by 8¼ inches on the sides and 7½ by 7½ inches on the back. All the bolts are nutted inside and out. The tops of the combustion chambers are supported by girders, four for each chamber. Each girder is composed of two plates 2 feet 6 11/16 inches long, 7¾ inches deep and ¾ inch thick. Each girder has three stay-bolts 1½ inches in diameter, equally spaced in the direction of its length. The girders are in no way stayed to the shell of the boiler.

The tubes are all seamless, cold-drawn steel, 3 inches outside diameter, 7 feet 4⅛ inches long. In each boiler there are 324 plain tubes, No. 8 B. W. G., and 180 stay tubes, No. 6 B. W. G. The tubes are spaced 4¼ inches horizontally and 4 inches vertically.

In the steam space of the boilers there are fourteen through stay rods, each 2½ inches in diameter, besides four diagonal stays 1⅞ inches diameter on each head. The through stays are prevented from vibrating by means of slings from the shell in the middle of the boiler. The portion of the heads between the tube nests is stiffened by two 5 by 4 by ¾-inch angle-bars riveted back to back. The lower part of the heads around the furnace ends is braced by six through stays 2¼ inches in diameter.

There is a 12 by 16-inch manhole in the shell of the boiler, giving access to the steam space, and five 11 by 15-inch manholes in each head in the furnace plate. These manholes are properly re-enforced and strengthened, as shown by the detailed drawings.

Photographs, Figs. 1 and 2, give a good idea of the size of the boilers and the design of the riveted joints, while Fig. 2 shows the method of drilling the furnace ends with a Haesler rotary drill.

THE HEATING AND VENTILATING OF SHIPS.

BY SYDNEY F. WALKER, M. I. E. E.

FANS USED IN VENTILATING.

There are two distinct classes of fans that are employed in ventilation, known as the "propeller" and the "centrifugal" fan. Their names practically explain them. The propeller fan is really a screw, constructed on the lines of the screw propeller of a steamship, and it screws air just as the propeller of a steamship screws water. It will be remembered that with any screw moving in any medium one of three things must move: the screw itself may move on, as where the ordinary wood or metal screw is moved into a piece of wood or metal; the object to which the screw is attached may move forwards, as in the case of many mechanical appliances, and, in particular, in the case of the steamship, which moves through the water as the screw drives it; thirdly, if the screw and the object to which it is attached are both fixed, the medium in which the screw turns must move, and this is what takes place with the propeller fan. As the fan turns it screws a portion of the air from one side of it to the other, just as the propeller of a steamship screws astern a portion of the water in which it is moving. But with air propellers the air only moves. Fans of this kind are available only for moving quantities of air under very low pressure. They do not create any appreciable water gage and cannot work against a resistance. If the air in front of them or behind them is throttled they produce practically no motion in the air. They are of great service for directing air from the outside of a cabin to the inside, or from the inside of a cabin to the outside, and for that purpose they should be fixed in the bulkhead of the cabin, or overhead in the beams of the cabin if preferred. Their office is simply to transfer the air, at a given rate, from the one side of the bulkhead or the beams to the other side. Fans of this type are often used to stir up the air inside of living rooms, saloons, etc., and they undoubtedly do stir up the air, but it can hardly be said that, when used in that way, they produce ventilation in the proper sense of the term. Churning up the air in a room may tend to assist ventilation to a small extent, but it can hardly be said to produce ventilation itself.

FIG. 68.—STURTEVANT FAN DRIVEN BY ELECTRIC MOTOR.

The centrifugal fan works on the same principle as the centrifugal pump. In its simplest form it consists of a number of blades, arranged radially around a central space and fixed between two disks. As the blades are revolved the air in the spaces between them is driven outwards by centrifugal force, a difference of pressure being created between the central space and the periphery of the fan. This causes air to enter the central space, and the air that has been forced outwards to be delivered from the periphery at a certain velocity. Numerous patents for the construction of centrifugal fans are in existence all designed to increase their efficiency. The simple fan described above is not efficient, because the air between adjacent blades is not simply forced outwards. A portion of it is forced outwards, but other portions form eddies between the blades, the eddies absorbing power from whatever is driving the fan, and reducing the quantity of air usefully delivered.

The various forms of fans are principally on the lines of curvature of the blades, somewhat similar to the curvature of the blades of centrifugal pumps, the object being to eliminate the eddies formed in the air between the blades, to direct the air into the spaces between the blades, and again to direct it

FIG. 69.—STURTEVANT FAN.

out at the periphery of the fan, with sufficient energy to perform the work it is intended for, but with no surplus energy. With centrifugal fans practically any pressure that may be required can be obtained. It is not necessary to mention to marine engineers that air pressure is measured by inches of water gage, but it may be mentioned that with modern centrifugal fans pressures as high as 10-inch water gage have been obtained, and greater pressures could be produced if required. On the other hand, for ventilating purposes, the pressure should be kept as low as possible. As mentioned, at the Birmingham General Hospital the pressure at the fan is only 1/20-inch water gage, but in the great majority of cases pressures from 1 inch and upwards are employed.

Fig. 68 shows one of the Sturtevant Company's* plate fans, constructed for pressure or exhaust. Another type of the same make is shown in Fig. 69. In Fig. 70 is shown a fan built by the Sirocco Engineering Company, New York.

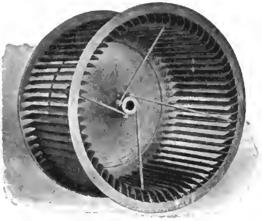


FIG. 70.—SIROCCO FAN.

SIZES OF FANS REQUIRED.

The size of the fans required for driving air through spaces to be ventilated depends upon two quantities: the volume of air to be delivered per minute and the velocity or, what amounts to the same thing, the pressure at which it is delivered. The problem is very similar to that of the chimney for the boiler furnace, and to that of the fans employed for furnishing forced or induced draft. It will be remembered that the sectional area of the chimney must be large enough to accommodate the quantity of hot gases that may have to pass through it when the boilers are doing their hardest work, and it must also be high enough to give the requisite motive column to drive the air and gases through the furnace, flues, etc. Similarly, with forced and induced draft the fans must be large enough to allow of the passage of the air or hot gases through them without throttling, and must be able to produce the necessary pressure to drive them.

With ventilating the same thing occurs. The fans employed must be large enough to allow of the passage through them of the largest quantity of air that may be required, and they must be able to furnish the pressure necessary to drive that quantity of air through the ventilating system.

With the propeller fan, the size of the fan, that which rules the quantity of air it can pass, is its diameter, and the pressure obtained from it depends upon its speed. The pressure obtainable with any propeller fan is very small, and in practice on board ship only very small fans are employed, driven usually by small electric motors, and capable of handling the ventilation of cabins, small mess rooms, or of assisting, or as electrical engineers would say, "boosting," the ordinary ventilating current in saloons, etc. There is a point that may be mentioned in connection with propeller fans, though it will hardly come into the practice of heating and ventilating on board ship. As explained, the propeller blades carry the air from one side of the fan to the other as they move, just as the propeller of a steamship carries the water from one side of it to the other, but while this is true of the outer portions of the blades of the propeller, there is a return air current at the center of the propeller, which may be seen by testing with a ribbon, or something of that kind. This return current, which is in the nature of an eddy, very much on the lines of the eddies that seamen are familiar with in rivers and on the coast, necessarily lessens the efficiency of the fan, and requires more power to be employed in driving it.

With centrifugal fans, the size, in the sense of the ability to accommodate volumes of air, the size which corresponds to the sectional area of the chimney, is the width of the fan, the width between the disks which usually inclose the blades. The wider the fan the larger the quantity of air it will accommodate without throttling. It will be understood that the air passages in a fan offer resistance to the passage of the air through them, just as the passages through which steam passes in doing work offer resistance to its passage, and that this resistance makes a charge upon the power that must be delivered to the fan shaft by the electric motor, or whatever is driving it. Thus a small fan may require a larger power than would be necessary to do the same amount of work in moving the air by a larger fan.

The pressure delivered by the fan varies with the square of its speed. It is not possible to give any rule for the size of fan required for any given work nor the speed, because there are so many fans upon the market, every one of which differs in the pressure it furnishes per revolution and in the capacity for allowing the passage of air.

THE POWER REQUIRED BY THE FAN.

As marine engineers know, power is required to move the air under any given conditions, and it depends directly upon the quantity of air to be moved and on the velocity at which it is moved. Air has weight, and creates friction when moving through pipes, ducts, etc. Both of these features demand the expenditure of energy when the air has to be moved. The matter may be put in another way—the power required depends upon the velocity at which the air is moved and the pressure that is required to move it. In the case of a complete ventilating circuit, from the entrance of a duct leading to a room to be ventilated, to the exit from the duct leading back to the atmosphere, the power required will be measured by the velocity at which the air is moved, multiplied by the difference of pressure between the inlet of the fan and the exhaust of the system. The pressure would be measured, of course, outside of the fan or other apparatus employed to move the air.

It will be noticed that the conditions are exactly the same as in the case of an electric circuit. It will be remembered that the power required in an electric circuit is measured by the current passing in the circuit, multiplied by the pressure required to drive the current through the circuit.

In the case of air, the whole of the pressure employed in the air circuit must be taken into the calculation for finding the power required. Thus, if the air is moving under a pressure of 2-inch water gage, and the duct has an area of 12 square inches, the total pressure will be 24-inch water gage, or a total of 13 ounces; 1-inch water gage it will be remembered, being equal to 0.55 ounce on the square inch. When the total pressure and velocity are known the horsepower in the air is given by the formula

$$\text{H. P.} = \frac{p \times v}{33{,}000},$$

* Hyde Park, Mass.

where p is the pressure in pounds per square inch and v is the velocity in feet per minute. This, however, is the horsepower in the air only, and takes no account of the efficiency of the fan or other losses; and in estimating the actual horsepower required, when the quantities given above are known, it will be wise to double the figures obtained from the last formula.

It was mentioned above that the pressure created by a centrifugal fan varies as the square of the speed. The power absorbed by the fan varies as the cube of the speed. When the speed of a fan is increased two operations take place: the quantity of air delivered by the fan is increased, and the pressure at which the air is delivered is also increased, and hence the cube ratio for the power. When a fan is running, each blade, as it goes around, delivers a certain quantity of air to the duct, or whatever it may be delivering into, and the greater number of revolutions the fan makes the greater is the quantity of air delivered and in exactly the same proportion. The velocity of the air issuing from the fan necessarily varies as the square of the speed of the fan in accordance with the well-known laws.

TESTING THE AIR CURRENT.

In any system of ventilation, or of combined heating and ventilating, it is necessary to test the course of the ventilating

FIG. 71.—THE MICROMANOMETER.

current and also the velocity. The course of the ventilating current can be traced with comparative ease by the use of light pieces of ribbon held on the end of a stick in the air current. The paper windmills that are made for children to play with are also very useful for the purpose, as, if properly made, they are very sensitive. They must be placed, it will be remembered, with their axes facing the direction of the wind, and they will be found to show the direction and a rough approximation of the force of the wind very readily.

To estimate the velocity of the air current an anemometer must be employed. It is an instrument which requires a considerable amount of skill in handling. It consists of a short brass cylinder, carrying what is virtually a small propeller fan pivoted on an axis in the center of the cylinder, and arranged to count up its revolutions on one of the usual dials. The apparatus must be placed so that the fan blades receive the air current in the same manner as an air current would be created by a propeller fan, and the test is made by counting the number of revolutions in a given time.

MEASURING THE AIR PRESSURE.

The simplest method of measuring the air pressure is by means of the apparatus with which marine engineers will be familiar—the water gage—consisting of a U-tube, having water in the bend and arranged for the two ends of the tube to be open to the portion of the air current between which the difference of pressure is to be measured. Measurements of the pressure between the atmosphere and any portion of a ventilating air current are made by allowing one end of the tube to be open to the atmosphere and connecting the other end to the air current whose pressure is to be measured. Water gages are often arranged with one end of the tube bent at right angles, the tube itself being held upon a flat board, very much in the same way as a thermometer is held, and the bent end of the tube being pushed through a hole in the board. A length of india-rubber tube can be employed to connect the ends of the tube with the atmosphere to be measured.

For measuring very small differences of pressure the micromanometer shown in Fig. 71 may be employed. It is claimed that readings to 1/2000 millimeter may be obtained.

ESTIMATING THE HEAT TO BE PROVIDED.

In the preceding sections the writer has explained how the heat is delivered from the different appliances to the air of the room, how the air entering a room is heated and how the ventilating current is made use of to heat and cool a room, etc. In a later section he proposes to estimate the probable quantity of heating apparatus and the probable current required to heat a large ocean liner throughout by electricity. Before doing so it will perhaps be as well to consider how the heat that is required has to be estimated.

In the earlier articles it was pointed out that the heating apparatus in a great many cases was left to heat up the room, the saloon, etc., as best it could; and in other cases the air was heated as it entered the room, either by appliances in the room or by appliances placed in the path of the air current. But he has not dealt in detail with the quantity of heat that has to be provided. The conditions, of course, will vary with the different climates a ship may be passing through and with the different times of the year, but the same rules will apply in all cases. It is not sufficient to assume that the air of a room is heated up by the heating appliance and remains heated. This is what used to be assumed in the old days of open fireplaces and natural ventilation.

The modern heating and ventilating engineer carefully estimates the quantity of heat that passes out of the space to be warmed in exactly the same manner as he estimates the quantity of heat that he can deliver to the space through the surfaces of his heating appliances. Evidently there will be two distinct sources of loss of heat in any room to be warmed—the entrance of cold air from outside and the passage of heat, from the room to be heated, through the walls, floors, ceilings, etc. The first source of loss, the entrance of cold air, is exceedingly difficult to estimate for. It is usual to provide against it, as far as possible, by warming the corridors, alleyways, vestibules, etc., and in the present case it will be left out of the calculation, it being assumed that the air of the alleyways, etc., is warmed to a temperature of 10 degrees above that of the outside atmosphere. The heat to be provided then consists of two quantities—that required to raise the temperature of the air and the objects in the room to the desired amount, and that required to replace the heat passing out through the walls, floors, etc.

THE HEAT PASSING OUT THROUGH THE SHIP'S SIDE, BULKHEADS, ETC.

It will be understood from what has been said with regard to the passage of heat from a higher temperature to a lower,

that the rule given as to the passage of heat from a heating appliance to the surrounding air applies equally to the passage of heat from the air in a stateroom to the water outside the ship, or to the air on the other side of the bulkheads, the other sides of the deck, etc. That is to say, the passage of heat through the ship's side, the bulkheads, etc., will be in direct proportion to the difference of temperature between the inside of the stateroom and the water or air on the outside of the ship or the bulkhead, in direct proportion to the surface exposed to the action and to the thermal conductivity of the substance of which the walls of the stateroom are composed. The heating appliance, whatever it is, must deliver heat to the stateroom at the same rate as it is carried off.

Assuming the temperature of the stateroom to be maintained at 70 degrees F., the temperature to be worked to outside the walls of the stateroom is evidently the lowest that is likely to be met with during the ship's voyage, and this will vary with the climates into which the ship goes and with the seasons. Whalers and sealers, and ships which go into the very cold regions in the neighborhood of the Arctic circle, will be subject to very low temperatures, while those which are engaged in the bulk of the ocean traffic, crossing the Atlantic and the Pacific in various directions, will not have such wide variations. In the calculations which follow, a minimum temperature of 30 degrees F. is taken for the sea and 40 degrees F. for the air outside of the staterooms, with the proviso that for ships in which lower temperatures are met with, these lower temperatures must be substituted in the calculations. It is also assumed that the air in the alleyways, corridors, and generally between decks, will be warmed to a temperature 10 degrees above that of the outside atmosphere.

In houses in Canada and America, that are subject to very low temperatures in winter, it is usual to raise the temperature of the halls, passages, etc., to very nearly that of the living rooms, as serious colds might be taken if this were not done. Also, in the case of institutions in the United Kingdom, such as hospitals, hotels, technical colleges, etc., that are warmed and ventilated on the plenum system, the temperature of the corridors, passages, etc., is practically the same as that of the wards, coffee rooms, class rooms, etc.

Take a stateroom having a cubical capacity of 1,100 cubic feet—this figure is taken to simplify calculations—the dimensions being 12 feet long (fore and aft) by 11½ feet wide and 8 feet high. The surface exposed to conduction from the air of the room to the water outside will be 96 square feet, and that exposed to the air, either of other staterooms or of corridors, etc., will be $8 \times 35 = 289$ square feet. The surfaces of the decks, above and below, will be $2 \times 138 = 276$ square feet.

We may consider that the 96 square feet of the ship's side is subject to a difference of temperature of 40 degrees F. Iron has a conductivity, according to Box, of 233 British thermal units per square foot per hour per 1 degree F. It will be seen, if the stateroom is not lined with wood on the ship's side, how enormous will be the transference of heat from the air of the room through the ship's side to the water. Under the conditions given above the quantity of heat passing out would be over half a million units per hour, requiring a very large heating apparatus to replace it. Incidentally, this shows the difficulty of warming parts of the ship where the naked side plates, etc., are exposed to the water on one side and the air of the ship on the other in very cold climates, and the advantage of wooden ships, in this respect, in cold climates.

A study of cold-storage methods enables the problem to be very effectively dealt with, and the passage of heat from the staterooms, saloons or any part of the ship to be effectively prevented. A lining of wood is in itself effective, because wood has a conductivity, according to Box, in the neighborhood of 0.8 unit per hour for a thickness of 1 inch, and if the wood lining is so arranged as to inclose a small air space between itself and the ship's plates, and more particularly if the air space is divided up into small spaces, so that convection air currents shall not have much room to circulate, and if the wood lining is thoroughly dry, the leakage of heat from the staterooms or saloons, under these conditions, may easily be reduced to 0.5 unit per hour per degree F. difference of temperature for each square foot of surface of the room all over.

Taking the dimensions given above, the total surfaces equal 652 square feet, of which 96 square feet will be transmitting 1,920 units per hour, and the remaining 556 square feet 8,340 units per hour, making a total of 10,260 units per hour, which would lower the temperature of a room of the size given 9.3 degrees F. per hour, unless it was replaced from a heating appliance.

With electrical apparatus this means that 3,000 watts must be delivered to the heating appliances, and this would require three of the usual four-lamp luminous radiators, one non-luminous radiator of 3,000 watts, two of 1,500 watts each, or any other equivalent. With hot water or steam, taking the rate given above of 1.5 heat units liberated per square foot of heating surface per degree F. difference of temperature, and assuming the hot-water apparatus to have a temperature of 170 degrees, 10,260 heat units would require approximately 70 square feet of heating surface. With steam at 210 degrees the heating surface would be approximately 50 square feet.

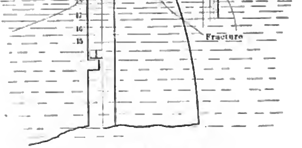
In the estimate for heating an ocean liner entirely by electricity the calculations have been made on these lines, the surfaces through which heat passes out being estimated, and the quantity of heat calculated from the differences of temperature, etc.

(To be Concluded.)

A Fractured Rudder.

The French steamship *Breiz Huel* broke her rudder, which was repaired at Fayal by means of a strap bolted across the fracture at the top and bottom. This, however, was carried away, and the break was renewed about as shown in sketch. After drifting for ten days, the ship was taken in tow by the British steamer *Sidra*, and after six days of towing reached Bermuda late in April.

The stock of the rudder was of cast steel, and the break occurred just under the upper pintle. After being surveyed in Bermuda the vessel left under her own steam for New York.



FRACTURED RUDDER OF THE BREIZ HUEL.

towing the tug *M. E. Luckenback* as a rudder. Repairs were finally completed in the Erie Basin, South Brooklyn.

The *Breiz Huel* is a steel screw steamer of 2,932 tons net and 5,097 gross, built in 1903 by the Chantiers de la Loire, at Nantes. She is 390 feet long, 50 feet broad and 26 feet 3 inches deep. She has seven watertight bulkheads, and is fitted for water ballast. Her triple expansion engine has cylinders 25, 42½ and 68½ inches in diameter by 44 inches stroke. The indicated horsepower is 2,200. Steam is furnished by three single-ended Scotch boilers.

The *Sidra* is a steel screw steamer of 2,033 tons net and 3,145 gross, built in 1893 by Irvine & Company, West Hartlepool. She is 322 feet long, 41 feet 7 inches broad and 21 feet 2 inches deep. She has web frames and five watertight bulkheads, and is fitted for water ballast. Her triple expansion engine has cylinders 23½, 39 and 64 inches in diameter by 42 inches stroke.

The *Breiz Huel* had another mishap late in August, having gone ashore near Aden. After removing 500 tons of cargo, she was floated without having sustained serious damage.

W. B SMITH.

THE WEIGHTS OF VESSELS.

BY ARTHUR R. LIDDELL.

The *Lusitania* and *Mauretania* are in some quarters being decried as monstrosities of naval architecture, which have indeed broken the Atlantic record at enormous cost, but which no ship-owning company, bent on earning profits, will ever attempt to rival. It is pointed out that the weights of vessel, machinery and fuel are such that the carrying of cargo becomes impossible, while the possible receipts from the passenger traffic are not sufficient in themselves to pay the expenses of working.

It is perhaps worth considering in what way the weights of such vessels might be reduced, and how possible reductions might affect the general design.

At the International Engineering Congress, held at Chicago in 1893, the late Direktor Middendorf, of the Germanischer Lloyd Classification Society, read a paper on *The Strength of Vessels*, which received less attention than it deserved. The paper contained detailed calculations of the reduction of the general scantling of a vessel's hull which the fitting of a central lattice girder would render justifiable. The value of the method was testified to by the president of the Congress (Engineer-in-Chief Melville), but copies of the paper not being in the hands of the members until the meeting began, no one was in a position to discuss it.

It may be premised that in his younger days Herr Middendorf had been well known as a capable shipbuilder, and had also himself built bridges and studied the theoretical principles underlying their design, so that his proposals, borrowed from bridge practice, must be taken with all seriousness. His contention was that a properly designed lattice girder at the center line of a vessel would take half the longitudinal strain usually borne by the sides of the structure. Detailed calculations of the strains and the necessary dimensions of the different members of the lattice girder were given by him for a twin-screw vessel of about 400 feet in length. The weight of the girder was 43 tons. On the strength of this Herr Middendorf advocated a reduction in the side plating of from 15 to 20 percent, which, as he showed, would still leave the longitudinal structure stronger than before.

The inconveniences attaching to such a girder were stated to be the necessity of fitting side hatchways, and the circumstance that the diagonal bracing might in some cases interfere with passenger accommodation and with the stowage of cargo; but none of these can be considered to be fatal objections.

If it be assumed that of the thickness usually given to the shell of a vessel, about half is required to meet longitudinal strains of the general structure, and half to meet local pressure of the water, blows of the sea, etc., which may act at the same time, it would appear that a possible reduction of one-quarter, or, roughly speaking, 70 to 80 tons, might be made in the sides in return for a weight of central girder of 43 tons. This latter weight is probably considerably overestimated, inasmuch as the strains due to water pressure and blows of the sea ought to have been deducted from the total to which the longitudinal structure was assumed to be subject.* The gain would here be about 50 tons, or, roughly speaking, about 2 percent of the whole weight of the hull on the shell plating alone. Probably other parts, such as keelsons and stringers, might be reduced as well.

A further means of lightening the hull consists in the general adoption of the system of widely spaced pillars and girders, from bulkhead to bulkhead, at the heights of the

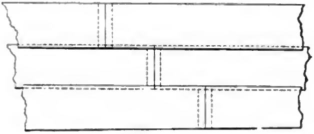


FIG. 1.

decks. This system saves weight in itself, but, when the spans of the beams are thus shortened, the latter may fairly be correspondingly reduced in section, and additional savings of perhaps 2 percent on the weight of the hull may be effected.

In regard to the framing of a vessel, it is by no means certain that the greatest possible lightness has as yet been attained. A judicious use of longitudinal girders and web frames, to take the main strains, combined with frames of reduced section spaced closer together, to withstand the local pressures on the shell, would no doubt result in a saving—it might be at the expense of space.

Another direction from which a saving in weight may come is that of the riveting. The hull of a vessel is constructed, to a considerable extent, of longitudinal strips of steel riveted together at their edges. The expanse of plating, shown in Fig. 1, represents three strakes of shell with butts shifted in the ordinary manner.

When two strips of plating of the same dimensions, the one with and the other without a butt, are severally submitted to tensile strain and tested to destruction, it will, as a rule, be found that the butt will open sufficiently to crack the paint and cause slight permanent set at less than half the strain which the plain plate will bear without rapid extension or "flowing" of its material. In fact, for practical purposes the butt is rather less than half as strong as the plate.

When several strakes are worked together, as in Fig. 1, the conditions become somewhat different. The rivets in the butt are very much more elastic than the plate material, and the result of this is that, when the three strakes have been submitted to tensile strain until the plates begin to slide over one another at the butts, and the paint cracks, the full plate of each of the two strakes adjacent to the butted one begins to be more severely strained in way of the butt than elsewhere. The tendency will be for the butt to open in the middle, while at

* The calculation was based on the assumption ordinarily made, that when a vessel is "at rest" upon the crest or in the trough of a high wave, the bending moment is nearly equal to the total stress which the material, as disposed, can withstand; i. e., when the parts farthest from the neutral axis are strained to their uttermost.

its top and bottom it will remain comparatively unstrained, but the adjacent strakes will be strained to a correspondingly increased extent.

Assume the strain which the butt will just bear without opening to be represented by 1, when the strake is unsupported at the sides. In the case of the three strakes assumed above, the strain on the material of the full plate at each side would then be 0.5, were it not that the butt at top and bottom is prevented from yielding. As it is, the full plate has to do a considerable share of its work. An exaggerated picture of what occurs is given in Fig. 2.†

The butt does perhaps five-sixths of its own work, *i. e.*, the strain taken by it is represented by $5/6 \times 1.0 = 0.833$. The remaining 0.167 of its work is borne by the full plates of

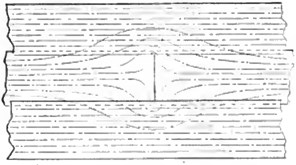


FIG. 2.

the adjacent strakes, 0.083 by each. If, in the adjacent plates taken separately, the solid plate be assumed to be twice as strong as a butt, the fibers of these will be half as much strained as the butt. With the addition of the 0.083 belonging to the butt, the mean stress on each of them increases to 0.583. The stress on one of the adjacent plates, however, is not the same throughout its width. At the side next the butt it may be $0.5 + 0.25 = 0.75$, while at the side away from the latter it may be 0.5.

Inasmuch as the side plates are also pierced at their edges by rivet holes, the strain on their fibers may there rise to 1. Fig. 3 gives a graphic representation of the probable strains to be borne by butt and adjacent strakes.

To take these strains, it is customary to apply to the butt itself a riveted connection which is of equal strength from one side of the plate to the other. In the middle of the plate the connection is just strong enough for its work, while at the sides the strains it has to bear are inconsiderable. Meanwhile the adjacent plates, which do no small share of the work that is credited to the butt connection, receive no further support.

Referring again to Fig. 2, it will be evident from the examination of the lines of flow there indicated, that the relatively severe strain of 1.0 borne by the side plates is only local, and might, for the most part, be taken up by a comparatively small doubling fitted to this plate in way of the butt. Meanwhile, the butt connection might taper at top and bottom to about half its width at the center of the butt, or even less. If a butt-strap be adopted, it may perhaps be treble riveted (if necessary) at the middle of the butt, and allowed to taper, first to double, and finally to single riveting at the point on each side next the adjoining strake.

If the suggested doublings were adopted the fibers of the plating would nowhere be strained to more than about half the permissible intensity, while the butt is strained to the full. Thus the plating could be made thinner—perhaps by 25 to 30 percent—provided the butt connections were not reduced in strength. This, however, would mean that in the middle of each butt a larger number of rows of the smaller rivets, suitable for the thinner plates, would have to be made use of. Unfortunately, it is not always an easy matter to increase the number of rows of rivets in a butt connection. To space the rivets nearer together decreases the strength of the plate to too great an extent. We are then confronted with the problem of how to obtain the necessary strength with fewer rows of rivets, and a possible solution of it is the following:

If a butt be set slanting, say at an angle of 45 degrees with the direction of the strake, the spacing of the rivets, measured square across the horizontal plate, is decreased by about 30 percent, while the number of rivets in a single row is increased by about 40 percent. It becomes possible, then, to get

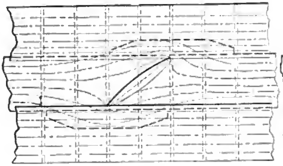


FIG. 4.

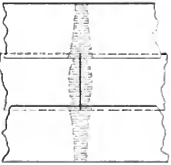


FIG. 3.

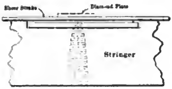


FIG. 5.

about the same rivet area into two rows as can be put into three rows with the vertical butt. Fig. 4 shows an arrangement of this kind, in which the frame crosses the butt in the middle of the strake.

Now it may at once be admitted that such a method of construction introduces complications—that it gives more scrap and more work in fitting plates and arranging rivets—and there would be the cardinal objection to it which is made to every novelty for its own sake; but the reward sought for, of a 20 to 30 percent reduction in the plating of a vessel, is one that is worth a good deal of brain work.

The case of a strake of plating, such as a deck stringer not accompanied by a steel deck, in which the butts are held fast at one side of the plate and not at the other, differs materially from the one above considered.

A graphic illustration of this case may be seen in Fig. 5. The point of greatest strain is not, here, the middle of the butt, but the unsupported end point of the latter, away from the sheerstrake. The butt connection has also to take up a larger part of the strain than that which it would have to meet in a totally unsupported strake of plating.

The proportion of the last-mentioned strain which the butt of a strake of plating has to withstand increases with the

† A strake of topside plating has been known to give way just below a butt of the sheerstrake, leaving the butt somewhat stretched, but still intact.

breadth of the strake. Further, the proportion of the same strain which the butt of a strake that is supported at one edge only has to take up is probably about the same as that in a strake supported at both edges, and having twice the breadth of the one supported at one edge only.

It follows, then, that a stringer that is without support, or that is only weakly supported at one of its edges, must have stronger butt connections than one which is strongly held on both edges. This explains the circumstance that the stringer plate is apt to give trouble at the butts sooner than the sheerstrake, even when it has the stronger butt connections of the two. The sheerstrake is strongly held within the upper quarter or third of its breadth by the stringer plate and angle. In way of a butt of the former, the unsupported breadth of the plate is also less than in the other strakes of plating of the vessel.

A suitable butt connection for a stringer plate supported at one edge only would be one having several rows of rivets at the unsupported side, and perhaps one row of rivets at the edge next the sheerstrake. The sheerstrake might suitably have short, diamond-shaped doublings in way of the butts of the stringer, where it is subject to extra straining in the manner shown above in connection with Fig. 2.

A longitudinal construction, such as was at one time advocated on theoretical grounds, is attended with drawbacks, not the least of which is that the present convenient method of setting up each frame in place and hanging everything else upon it, so that shoring and scaffolding are minimized, would have to be given up. One advantage which it might be made to yield would be the succoring of the butts of the shell plating in the middle, so that their connections would withstand greater strains without slipping, as above illustrated. It is true, the inner edges of the longitudinals would have to be strongly succored by angles or otherwise, but this would present no great difficulty.

There is another kind of butt connection occurring in floor plates, web frames, etc., which have to take strains applied at right angles to their breadth. For these, the ideal butt connection is one with several rows of rivets at each edge of the butted plate, and perhaps a single row in the middle. The outline of the riveting then has somewhat the form of an *x*.

Attention given to the work which the rivets really have to do will enable reductions to be made in the weight of rivets and plate overlaps, and in the cost of riveting, but the chief gain is an indirect one, in that it becomes possible to lighten the plating required to provide a given strength.

Much may also be done to reduce the strains on the longitudinal structure by a judicious distribution of the weights, so that upper or lower parts of the girder are not subjected to a constant strain, to meet which one-sixth or one-fifth of the thickness of the material must be "written off" before account is taken of the moment of resistance necessary to meet the effects of wave action, blows, and water pressure, usually provided against. If a vessel could be so designed that the most favorable possible distribution of her weights were always preserved, there is no reason why a reduction in her structure should not be made on this account also.

A somewhat heavy item on a fast passenger steamer is the luggage. Why should not some of the heavy luggage be sent by another and slower vessel? Why should not the space thus set at liberty be devoted to passenger accommodation? The electric light may have to be in constant use in the space thus utilized during the whole of the passage, but for four or five days the want of daylight may very well be borne.

The employment of oil as fuel, and that of explosion motors as propelling machinery, have been much discussed of late, and ideals of this kind may some day be realized. For the present these possibilities are still too remote for serious consideration, but it is evident, in view of the various methods suggested in the foregoing for the reduction of weight, that further developments are possible either in the direction of an increase of speed or in that of economy and consequent reduction in the size of vessel now considered necessary for first-rate Atlantic work.

To sum up, savings may be expected under the following heads:

1. Lattice girder.
2. Longitudinal girders at decks, with lighter beams.
3. Better methods of longitudinal and vertical framing.
4. Improvement in riveted connections.
5. Part of luggage sent by slower vessel.
6. Lighter motive power and fuel.

The savings under heads 1 to 5 may average 2 percent on the displacement, and thus come to 10 percent in all, while that under head 6 may ultimately itself reach 10 percent or more.

But savings in weight may be hoped for from two other sources. One of these is the employment, to a greater extent, of stronger kinds of steel, which, however, is an expensive expedient; the other is the possibility of reducing the proportion of breadth to draft of the vessel. The scantling numbers of the classification societies provide sufficient strength for vessels that are broad in relation to their depth molded and draft of water. If the breadth be reduced and the numbers for the longitudinal and transverse structural parts remain the same (with the exception of that for the beams), the strength provided by these parts will be excessive; for, while the effects of wave action, as regards longitudinal bending moment, vary with the breadth, the moment of resistance of the structure of the vessel, looked upon as a girder, is the more advantageous the greater the proportion of breadth to molded depth. Now a reduction of breadth means a diminution of receipts from the passenger traffic, which is hardly counterbalanced by an increase obtainable in cargo-carrying capacity, and perhaps in relative capacity of the holds; but it is probable that any losses thus sustained will be more than balanced by savings which become possible in connection with the engines, boilers, and fuel.

A Remarkable Motor Boat Race.

On August 3 there took place on Huntington bay, Long Island Sound, an international motor boat race for the Harmsworth trophy, won in Britain last year by the *Dixie I.* The defenders this year consisted of the *Dixie II.*, the *Den* and the *U. S. A.*, while the two challenging boats, both English, were the *Wolseley-Siddeley* and the *Daimler II.* The race, as it finally turned out, was between the *Dixie II.* and the *Wolseley-Siddeley.*

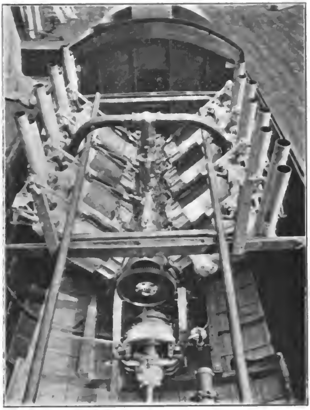
Of the five boats entered the *Diamler II.* was disabled and did not finish. The times for the three rounds of the course of 10 nautical miles (making a total of 30 nautical miles) and the speeds for the various sections of the course and for the entire run are given in the table.

	First Round.		Second Round.		Third Round.		Total.	
	Elapsed Time.	Speed, Knots.	Elapsed Time.	Speed, Knots.	Elapsed Time.	Speed, Knots.	Elapsed Time.	Speed, Knots.
Dixie II.	21 35	27 8	22 18	25 93	21 06	28 4	1 04 57	27.75
Wolseley-Siddeley	22 12	27 02	21 55	27 4	21 30	27 7	1 05 46	27 25
U. S. A. ..	25 15	23 75	24 59.	24 02	24 56	24 06	1.15 11	23 9
Den. .	26 55	22 28	27 01	22 2	26 51	22 32	1 20 47	22 25

A peculiar feature of the winning of the race was based on the fact that the exhaust pipes of the *Dixie II.* were so low as

to throw a large part of the exhaust gases into the faces of the captain and engineer who handled the boat. Both were seriously overcome by this gas, the engineer having fainted some distance from the finish, and the captain soon after he succeeded in stopping the boat, and just after the committee boat came alongside.

That the *Dixie II.* was not pushed to her limit is shown by the fact that her revolutions were far below that of which she is capable, and by the further fact that in four trials over a measured course of 1.1 nautical miles on the Hudson she has averaged a mile in 1 minute 54.34 seconds, which gives her a speed of 31.347 knots, or 36.049 statute miles per hour. The best record of the *Wolseley-Siddeley* is said to be 30.4 knots, or 34.96 statute miles per hour.



ENGINE OF THE DIXIE II., VIEW LOOKING FORWARD.

(Photograph, Levick, New York.)

The *Wolseley-Siddeley* has a length of 39 feet 4 inches, a beam of 6 feet and a maximum draft under the propellers of 2 feet 8 inches. The hull is built of timber throughout, with three skins laid vertically, diagonally and horizontally, respectively. The waterlines are straight for a distance of about 12 feet abaft the stem, with considerable flare above to lift the boat in a seaway. The stern has a nearly flat bottom, below which are the two propellers. The displacement of the boat in racing trim is just under 8,000 pounds, of which the machinery accounts for 4,200 pounds. Each of the two engines on the test bench weighed 1,670 pounds. Each has eight cylinders, mounted in pairs. They have developed a total of 460 horsepower at 1,100 revolutions per minute.

The *Dixie II.* has a length of 39 feet 6 inches and a beam of 5 feet 3 inches. The total displacement in racing trim is 4,700 pounds. She was designed by Clinton H. Crane and built by Frank Woods, City Island, N. Y. Her hull is covered with a single skin of mahogany sheathing. There is a 200-horsepower engine, designed for a maximum of 900 revolutions per minute, and operated during the race at about 750 revolutions. The engine consists of eight cylinders, mounted in pairs at 90 degrees, as shown in our illustration. The object of this design was to utilize to the best advantage the space in the boat, and to reduce to a minimum the weight of the crank case, which is said to be not much more than one-half that required for the eight cylinders in a vertical line. The cylinders measure 7¼ by 7¼ inches, and have developed a total of 230 horsepower, the weight of the engine being 2,150 pounds. The propeller is three-bladed, with a diameter of 26½ inches, and a pitch of 49 inches. That a boat with only half the power of her rival was able to triumph speaks volumes for the beauty of her lines and the perfect adjustment of the engine and propeller.

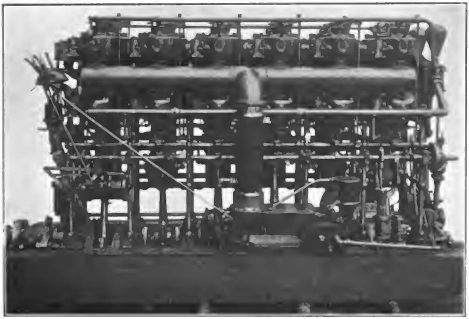
The Navy Collier Vestal.

Last May there was launched from the New York navy yard the first of two fleet colliers building for the United States navy. The *Vestal* has a length over all of 465 feet 9 inches; a length between perpendiculars of 450 feet; a beam of 60 feet 1 inch; a depth of 34 feet, and a full-load draft of 26 feet. At this draft she displaces 12,585 tons, and carries 6,410 tons of cargo coal, besides her bunker capacity of about 1,600 tons.

The ship is to be propelled by twin screws, each operated by a triple expansion engine. With 7,500 horsepower a speed of 16 knots is expected. A battery of four 3-inch rapid-fire guns is provided for protection against torpedo craft. There are four pole masts. The crew will consist of thirteen officers and 163 men. The total cost is estimated at $1,400,000 (£288,000).

THE UNITED STATES COLLIER VESTAL, LAUNCHED AT BROOKLYN.

(Photograph, R. E. Muller.)



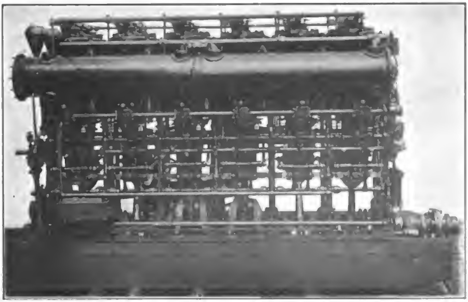
FRONT SIDE OF ONE OF THE AUSTRIAN PATROL BOAT ENGINES.

NEW AUSTRIAN PATROL BOAT ENGINES.

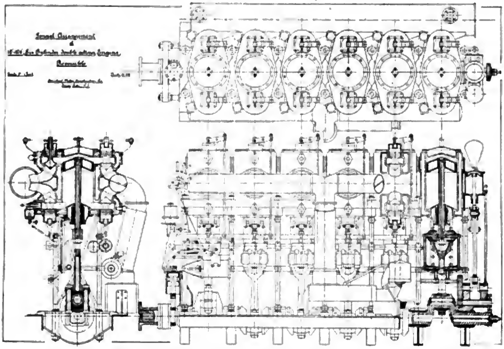
For the propulsion of two patrol boats to be used on the Danube, the Austrian government recently contracted with the Standard Motor Construction Company, Jersey City, for four reversible gas engines, each to develop 300 brake horsepower under constant work at a maximum of 400 revolutions per minute, and to permit a variation of speed down to 90 revolutions. The requirements called for a total weight of not more than 21,500 pounds, including all parts of the engine, and including also 706 pounds of water in the cooling pipes and jackets. The consumption of gasoline (petrol) of 0.72 specific gravity (65½ Beaumé scale) was required to be at full load from 0.3 to 0.32 kilogram (0.66 to 0.71 pound) per horsepower hour; and at half load, 0.38 to 0.40 kilogram (0.84 to 0.88 pound).

To meet these requirements engines have been designed of the six-cylinder, double-acting, reversible type, with shafts turning from upwards to inwards. The cylinders measure 10 inches in diameter, with a stroke of 10½ inches. The crank shaft, with its six cranks, is one solid piece, with a two-inch hole for water circulation, and is set in seven adjustable bearings. The thrust bearing is a roller bearing. The cylinders, piston rods and valves are water cooled. Lubrication is automatic and forced by means of pumps. Carbureters and igniters are of the Standard type, current being supplied from storage batteries.

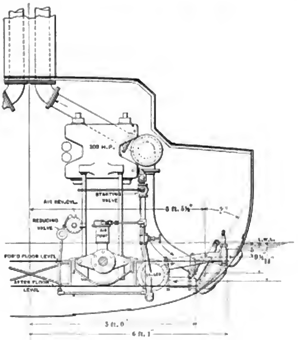
For starting purposes two air tanks, 18 inches in diameter and 96 inches long, serve to accumulate the necessary air and to operate whistles. A sufficient supply of compressed air is held in the tanks to start the engine fifteen or twenty times



REAR VIEW OF ONE OF THE AUSTRIAN PATROL BOAT ENGINES.



GENERAL ARRANGEMENT OF ONE ENGINE, WITH TRANSVERSE AND LONGITUDINAL SECTIONS.



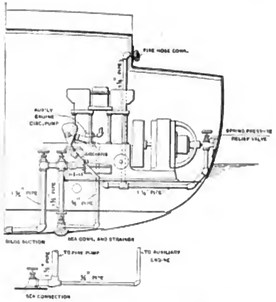
SECTION AFT OF ENGINES, LOOKING FORWARD.

without working the auxiliary air pump. The lowest and highest pressures allowed in the air tanks are, respectively, 7 and 17 atmospheres, corresponding with 103 and 250 pounds per square inch. Auxiliary engines are supplied with a direct-coupled dynamo capable of giving 4½ kilowatts at 65 volts. There is also attached to this engine an air compressor capable of giving pressures up to 250 pounds per square inch. This engine also drives a combination bilge and fire pump. The dynamo serves for charging the batteries for the igniter apparatus, and to light the boat.

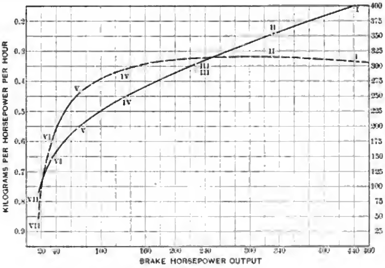
Each engine was subjected to a number of tests, among which was reversing from full speed ahead to full speed astern. This was done in between three and four seconds from the giving of the order, where the contract called for from fifteen to twenty seconds. In each case the engines

VARIABLE LOAD TEST.

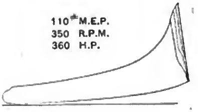
Weight on Scales, Lbs.	R. P. M.	Brake H.P.	Gasoline per H.P. per hour, kg.
1,155	400	441	0.33
985	350	328	0.32
800	300	227	0.36
572	250	136	0.37
355	200	68	0.42
258	146	37	0.6
150	88	17	0.85



WATER CONNECTIONS FOR SUCTION AND DISCHARGE.



THE FUEL CONSUMPTION AT VARYING LOADS ON BRAKE.

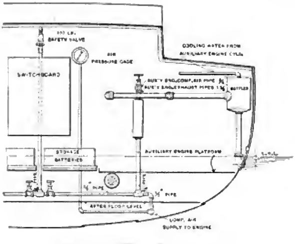


A SAMPLE INDICATOR CARD.

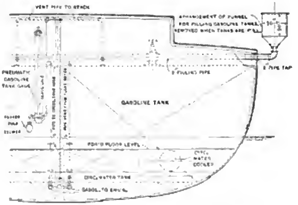
were tested for twelve hours at full load, and were then given tests at variable loads from considerably above the normal to a very low figure, and the tests were successful in every instance. The table for the first engine is representative of them all, and is here reproduced. During the twelve-hour run the load on the brake consisted of 873 pounds at a radius of 60 inches. During the other tests the load was varied considerably, as shown in the table.

TWELVE-HOUR TEST.

Time Taken.	R. P. M.	Brake H.P.	Gasoline per H.P. per hour, kg.
7.15 A. M.	364	303	0.33
8.15	372	310	0.32
9.15	370	308	0.316
10.15	374	311	0.3
11.15	366	305	0.29
12.15 P. M.	372	310	0.29
1.15	368	305	0.3
2.15	368	306	0.29
3.15	365	305	6.29
4.15	368	303	0.29
5.15	374	311	0.29
6.15	368	30[illegible]	0.28[illegible]
7.00 P. M.	365	305	0.288
Mean	368.9	307	0.2[illegible]



AFTER ENGINE ROOM BULKHEAD, LOOKING AFT.



FORWARD ENGINE ROOM BULKHEAD, LOOKING FORWARD.

Notes on the World's Torpedo Craft.

The successful trials of the Laird-built destroyer *Cossack*, which was the first of the big British 800-ton 33-knot class to attain her designed speed, went very far to assure everyone of the probable success of the bigger 36-knot destroyer *Swift*, which was launched in November. The *Cossack* attained 33.1 knots for six hours with some ease, her oil consumption working out slightly below the Admiralty limit. The revolutions on the full speed trial were about 760, the steam pressure on the boilers being about 230 pounds per square inch. All the vessels of this class are criticised for their weak armament—three 12-pounder rapid-fire guns and two 18-inch torpedo tubes. The *Mohawk*,* a sister ship, made 34.3 knots on her official trial, Nov. 5.

The French marine is about to follow the example of the British Admiralty in adopting oil fuel for the new destroyers of the 1907 programme. Three vessels have recently been ordered from Normand, the Chantiers de St. Nazaire-Penhoet and the Forges et Chantiers, at Havre, respectively. They will be about 208 feet long by 21 feet beam, and will displace 440 tons. The speed will be 28 knots, and the vessels will be fitted with Parsons turbines. They will be known as the *Fantassin* class.

The speed attained by *G 137* of the German navy on her recent trials placed her for the time being at the head of the list of fast torpedo craft. In spite of being slightly slower than the larger British vessels her performance of 33.1 knots when

* See page 455, November, 1907, for description.

displacing 580 tons is certainly very creditable, more especially as the other vessels built at the same time failed to attain the guaranteed speed of 30 knots. The German Admiralty lays great stress on strong hulls for all small vessels, and seaworthiness is often attained at the expense of a slightly lower trial trip speed. Twelve destroyers of about 540 tons are now in hand at the Vulkan Works, and should soon be ready for their trials.

Both Spain and Portugal have recently been asking for tenders for torpedo craft. The former government proposes to add to its fleet three destroyers of 350 tons, and twenty-five torpedo boats of 180 tons, the speeds being 30 knots and 26 knots, respectively. The Portuguese inquiry, which was limited to two 350-ton destroyers and six 150-ton torpedo boats, all of 27 knots speed, was probably more widely tendered for than any similar contract of recent years, and the designs submitted varied enormously in almost all details. Turbine machinery is favored by both navies.

Neither Italy nor Russia seems to be adding to the torpedo flotillas at present. The former country has recently completed a satisfactory 370-ton class of 6,000 horsepower, carrying four 12-pounder guns and three torpedo tubes, but in spite of innumerable tenders for all sorts and conditions of boats and destroyers the Russian government has as yet refrained from placing any orders abroad or at home.

The United States adheres to a wise policy in building large and comparatively slow destroyers. They are never likely to be required except in home waters, and the crossing of the Atlantic would be a difficult feat for most of the European boats. The original orders for torpedo craft in the United States some years ago gave builders a considerable amount of trouble, but no difficulty should be experienced with the five new 28-knot boats, which are being built by Cramp & Sons (2), the Bath Iron Works (2), and the New York Shipbuilding Company (1). Ten more are authorized.

Japan builds all of her own mosquito fleet nowadays, but is not at present attempting anything uncommon, though rumor credits her with laying down a 35-knot boat of 1,100 tons.

Chilean and Argentine orders for destroyers seem to have ceased, but a 26-knot boat has just been completed for Brazil by Messrs. Yarrow. This vessel is similar in hull design to innumerable torpedo boats turned out by this firm, but is remarkable for the adoption of a small reciprocating engine in conjunction with Parsons turbines. This system had been practically abandoned by Messrs. Parsons for fast boats, though Rateau is using it in his French destroyer of 7,200 horsepower, now building. Brazil recently ordered several large destroyers from Yarrow, and these are now under construction at the new Clyde works. They will have reciprocating engines. One has already been launched.

No less than four destroyers, built on speculation, were lately lying in English yards awaiting purchasers. Two 25½-knot 570-ton boats were built at Laird's, where they have lain for two years since their trials; they are practically identical with the "river" class destroyers built for the royal navy by that firm. The other two destroyers have been built by Palmer at Jarrow, and have been running trials at intervals during the last twelve months. They displace 400 tons and have attained speeds of 31 to 32 knots. The two Laird boats are fitted with piston engines and the Palmer boats with turbines. Both vessels can carry one 12-pounder and five 6-pounder guns, as well as two torpedo tubes. Two have been bought by the Admiralty, to replace boats lost in maneuvers.

The most interesting feature in the past summer, as far as destroyer work is concerned, was the trials of the *Swift*. This 1,800-ton vessel succeeded in exceeding her speed for the guaranteed period of eight hours, being credited with 38.3 knots.

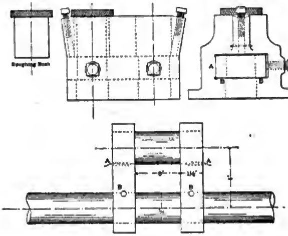
The real problem of the future seems to be one of cost—speed can be attained at a price.

Engine Cranks Built Up Without Turning.

The writer some years ago had a number of small cranks to make for long-stroke steam launch engines, and as these were running at a slow speed, a somewhat novel idea was tried with considerable success. Seeing that *no turning whatever* was done, a remarkably true and satisfactory job was turned out.

The procedure was as follows: Flat steel, 3 by 1½ inches in section, was planed all over, and cut to correct length for the cheeks. Care was taken to keep two edges square, as these were made to register in the drilling jig, which is a strong gray-iron box open at both ends, machined on the bottom and two inside faces, *A* and *B*, at right angles. It is bored to receive a set of drilling and reaming bushes, and is provided with two sets of holding screws at top and side, as shown.

The crank cheeks were inserted one at a time (this was found to make a truer job), with their "*true*" edges bedding against the side and bottom, drilled and reamed to 2 inches, less 0.005 diameter, through both holes for shaft and pin. On



removing them a letter was stamped on the edge bedding on the jig register marked *B*, to insure this face again being used to register when shrinking together.

Bright, 2-inch stock was next selected, which was found to be within 0.0015 inch of round and true. One piece was cut off to length of crankpin, and one piece to total length of shaft over all.

After removing all burrs, the crank cheeks were mounted on the shrinking plate, a gray-iron plate 2 inches thick, with a number of slot holes cast through to receive holding-down bolts. Both cheeks were placed the correct distance apart, and lightly clipped down; the whole was brought over an open fire on the brazing hearth, and the blow-pipe turned into the cheeks and plate until a dull-cherry heat was obtained. The crankpin was then slipped through flush, and as quickly as possible the crankshaft inserted right through both cheeks to the correct distance, and the holding clips released. The shaft end of cheeks was sprayed to induce this end to grip first, when the crank resembled the lower figure.

Holes were next drilled to receive the keys at *A* and *A*, also at *B* and *B*. The shaft keys were put in at right angles, as shown, to facilitate drilling, but if preferred, could have been put in with the ratchet. These keys were also shrunk in place, the crankshaft again being heated for this purpose, and keys lightly driven home. The next operation was to remove the centerpiece between the cheeks. This was done under the cold saw, and the whole polished up and tested for truth.

The objection to this type of crank is, of course, the absence of any radius or fillets at the corners; but this was met,

in the case in point, by allowing a very high factor of safety, with the happy result that no defect whatever showed after being put to work.

These cranks, when tested, showed that unturned cranks *can* be produced; the shaft in this case did not vary more than 0.002 inch out of line—quite as good as a great many turned cranks would be found.—*American Machinist.*

THE STEAMSHIP CHICAGO, OF THE FLEET OF THE COMPAGNIE GENERALE TRANSATLANTIQUE.

THE ATLANTIC LINER CHICAGO.

BY J. G. PELTIER.

On the 5th of November, 1907, this new twin-screw transatlantic liner was launched from the yards of the Chantiers de l'Atlantique at St Nazaire-Penhouet. She is now in service between New York and Havre. The ship has the following particulars:

	Meters.	Feet.
Length over all	159.6	523.7
Length between perpendiculars	152.92	501.8
Breadth, extreme	17.6	57.8
Depth (to spar deck)	13.	42.6
Astern draft, fully loaded	7.8	25.6

Displacement, fully loaded	14,500 tons
Gross register tonnage	11,103
Mean sea speed	17 knots
Trial speed (24 hours)	17.66 knots

The hull is of mild steel, giving the highest quotation to the Bureau Veritas; materials have been calculated to give the hull the best strength. From stem to stern the ship is divided into thirteen watertight compartments by twelve watertight bulkheads; these are pierced only by indispensable doors, which number eight. These doors are of the usual patent hydraulic closing type and may be closed from the navigating bridge, if necessary; this gives good security.

There is a complete cellular double bottom from end to end of the ship; this has a total capacity of 1,700 tons of water, which allows good seaworthiness on ballast trim. The double bottom and the different watertight compartments are connected with pumps and pipes, these former being able to discharge 1,385 tons of water an hour, which will be sufficient to maintain the ship afloat under ordinary collision conditions.

THE STEAMSHIP CHICAGO, OF THE COMPAGNIE GENERALE TRANSATLANTIQUE, ALONGSIDE THE PENHOUET WHARF.

THE TRANSATLANTIC LINER CHICAGO, AND THE 150-TON CRANE, UNDER CONSTRUCTION.

There are nine decks, viz., the third, second and first 'tween decks; the fourth, third, second and main decks, the spar deck, the promenade deck and the awning deck. The last two are not the full length. On the awning deck are the officers' accommodations in a large deckhouse. On the promenade deck are the drawing room, the smoking room, the ladies' room and the entrance to the first class accommodations.

On the spar deck is a large deckhouse, 220 feet in length, in which are, from stem to stern, the first class dining-room, numerous first class cabins, bath rooms, children's room, etc. Aft of the large house are two small houses, one for the third class social and smoking room, the other for the steering apparatus, the entrance to the third class and to the steerage passengers' accommodations. In the forecastle are accommodations for the petty officers and stewards.

On the main deck are from stern to stem: stewards' and stewardesses' rooms, third class passengers' accommodation, steerage passengers' rooms; in the center, first class passengers' accommodations; in the way of the engines, the engineers' rooms; in the way of the funnels, kitchens, etc., forward are steerage passengers' rooms and crew quarters. There are no passengers of the second class on board this liner.

The first class social hall and others are decorated in the Louis XV. style, as well as the dining room, smoking room and ladies' room. The dining room contains 118 seats, the passengers being accommodated, as usual, by small tables for from two to ten passengers each. The third class passengers' dining room is at same time a social hall and smoking room, and contains seventy-four seats. There are no "cabines de luxe," but there are ninety-eight cabins of first class, 184 of third class, and beds for 1,055 steerage passengers.

As shown in the accompanying photographs, the lines of this liner are very fine, and as the engines answer to the design, the contracted speed was easily attained on trial trips. All apartments are heated by hot water; the heat may be maintained at a temperature of about 18° C. (65° F.). The ventilation is effected by electricity, and in the first class cabins, each passenger can regulate the ventilation of his own cabin. Numerous bath rooms, fitted with cold and warm water, are at the disposal of the passengers; the wash stands are also supplied with warm and cold water throughout the ship.

The two main engines are of the usual triple expansion type, three cylinders having, respectively, the following diameters: 27, 44 and 74 inches, with a stroke of 54¼ inches. At ninety-five revolutions per minute, the indicated horsepower is about 9,500. The steam is supplied to the main engines and auxiliaries by nine cylindrical boilers of the marine type, working at a pressure of 193 pounds per square inch. These boilers have a total surface of grate of 575 square feet; the heating surface is of 20,630 square feet. The boilers have twenty-three furnaces and are served by two large funnels.

The use of electricity is considerable. There are two 140-kilowatt (110 watts and 1,270 amperes) dynamos operated by steam turbines. The winches, capstans and boat winches are

ONE OF THE ELECTRIC CRANES USED IN BUILDING THE CHICAGO.

PREPARING THE WAYS FOR LAUNCHING THE CHICAGO.

electrically driven, and, of course, the ship is lighted by electricity. There are also refrigerating engines, having a power of maintaining a temperature of — 5° C. (23° F.) in the cold store rooms. These engines are of the Linde type, operated by duplex engines. The ship is fitted with wireless telegraphy and submarine signaling equipment.

There are sixteen steel boats, of which fourteen are life boats, and five life rafts, fitted with Welin quadrant davits, allowing them to be launched in 40 seconds by four men only, whatever may be the situation of the ship. The crew of this liner includes seventeen officers (deck and engine), 115 men (sailors, stokers, firemen and engineers), and sixty-two stewards and stewardesses. The total number of persons that may be carried is 1,700, all included.

A NEW PATROL STEAMER FOR FISHERY DUTIES.

The twin screw patrol steamer *James Fletcher*, owned by the Lancashire & Western Sea Fisheries Committee, for patrol duties in the Irish Sea and on the west coast of England and Wales, has recently been built by Philip & Son, Ltd., Dartmouth, from the designs of Alexander Richardson, of Liverpool. She is of the following dimensions:

	Feet.	Inches.
Length over all	147	..
Length between perpendiculars	139	6
Beam molded	23	6
Depth molded	13	6
Draft aft	11	..
Draft forward	8	..
Draft mean	9	6

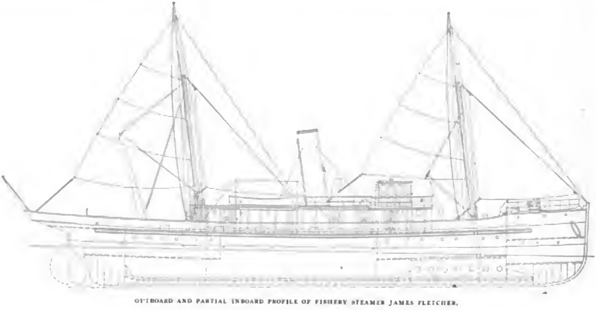
Displacement, corresponding to this draft, 420 tons.

The vessel is built of Siemens-Martin steel throughout, and classed 100 A1 under Lloyd's special survey, and under the Board of Trade rules and regulations with regard to accommodation, tonnage, lights, signals and life-saving appliances.

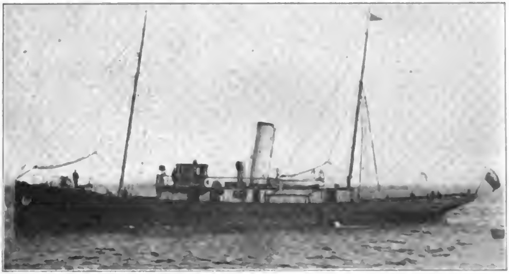
The stem and heel are of bar iron, 6½ by 1⅛ inches, in long lengths, properly scarfed together. The stern frame is of the best hammered scrap iron, 6¼ by 2¾ inches, and fitted with solid rudder gudgeons, stoppers and heel steps. The rudder is of the single-plate type, with the frame of the best hammered scrap iron. The plate is ¾ inch in thickness and the head is 5 inches diameter. The pintles are of the portable type, 3¼ inches diameter, and the gudgeons in which they work are bushed with hard gunmetal.

The main frames are of angle steel, 3 by 2½ inches by 6/20 inch, extending in one length from heel to gunwale, and spaced throughout 22 inches apart between centers. Floor plates are fitted to each frame, 13 inches deep at center line, tapering to width of frame at the ends. These are 6/20 inch thick forward and aft of the machinery space, 7/20 inch under the engines, and 8/20 inch under the boiler. Reverse frames are fitted to every frame, 2¾ by 2¾ inches by 6/20 inch, increased to 7/20 inch and 8/20 inch in wake of machinery.

There are four watertight bulkheads, each built of 4/20-inch plates on 5/20-inch floor plates, and stiffened with angles 3 by 2½ inches by 6/20 inch. The transom frame and the frames that carry the counter are of 5/20-inch and 6/20-inch plates and 3 by 2½ inches by 6/20-inch angles.



OUTBOARD AND PARTIAL INBOARD PROFILE OF FISHERY STEAMER JAMES FLETCHER.



THE FISHERY STEAMER JAMES FLETCHER READY FOR SERVICE.

The middle line keelson is of bulb plate, 10 inches by 10/20 inch, and 3 by 3 inches by 6/20-inch angles, extending along the top of the floors from the forward to the after bulkheads, to which they are connected by strong brackets. The side keelsons and bilge stringers are each of double angles, 3 by 3 inches by 6/20 inch, extending on reverse frames and lugs, all fore and aft, connected at the stem by strong breasthooks, and well bracketed at the after end of the transom. Intercostal plates 5/20 inch thick are worked between the side keelson angles for three-fourths length amidships. The engine and boiler seatings are very strongly constructed of plates and angles, the main frames and floors being utilized as far as practicable. The coal bunkers are of 80 tons capacity, and are of 4/20-inch and 5/20-inch plates and 2½ by 2½ inches by 5/20-inch angles.

Under the forward accommodations, deep tanks are built in the vessel; they are of 5/20-inch steel plates, and stiffened by 4 by 2½ inches by 6/20-inch angles. This tank is divided into two compartments, the forward part being used as a ballast tank and the after part as a fresh-water tank for reserve feed for boiler.

The main deck beams are on alternate frames, and are of angle steel, 6 by 3 inches by 8/20 inch amidships, diminished to 5½ by 3 inches by 6/20 inch at ends. They have a camber of 6 inches in the full breadth of vessel. The lower deck beams are 5½ by 3 inches by 6/20 inch, and are straight across. The hold stanchions are of solid steel, 2⅛ inches diameter.

The upper deck stringer plate is 24 inches by 6/20 inch amidships, reduced to 19 inches by 5/20 inch at ends, and is connected to the sheer strake by a continuous gunwale angle 3 by 3 inches by 6/20 inch. The lower deck stringer plate is 19 inches by 5/20 inch amidships, to 14 inches by 5/20 inch at ends. A continuous tie plate, 7 inches by 6/20 inch, is worked on the main deck beams all fore and aft in a line with the deck erections. The usual deck plates are fitted on the beams under the windlass, winch and in wake of masts and other erections.

The main deck is of yellow pine, 3 inches thick, with margin planks of teak all around the waterways and deck erections. The bridge deck is of yellow pine 2 inches thick, also with teak margins.

The shell plating includes garboard strake of 8/20 inch thickness all fore and aft, bilge strakes, 7/20 inch to 6/20 inch; sheerstrake, 9/20 inch to 6/20 inch, and the remainder 6/20 inch to 5/20 inch, the thicker plates being for about two-thirds the vessel's length amidships. The bulwarks are of 5/20-inch steel, and surmounted by a rail angle of Tyzach's section. Doubling plates are fitted to the bulwarks in wake of the hawse and quarter pipes, and the bulwarks are stiffened and supported by galvanized wrought-iron spur stanchions, spaced about 4 feet apart. All the fore-and-aft edges of shell plating are overlapped and single riveted, and all the end butts throughout are flush and double riveted, with inside straps.

Bilge keels are fitted on each side for half length of vessel amidships. They are of steel plate, 8/20 inch thick by 12 inches deep, and are attached to the shell by double 3 by 3 inches by 6/20-inch angles.

The deck erections are of 5/20-inch steel, stiffened by angles 3 by 2½ inches by 6/20 inch, these angles being carried across the top, so as to form the beams for the bridge deck. The whole of these plates are flush butted, with external butt straps, fitted so as to form panelling. All the doors in the deck houses are of teak.

The accommodation on the main deck includes a large and roomy chart house and deck saloon, extra large galley and the usual lamp rooms, toilets, storerooms, etc. This is all forward of the boiler room, but the erections are continued over

THE SHIP AFTER LAUNCHING. IN THE BACKGROUND IS THE NAVAL CADET TRAINING SHIP BRITANNIA.

the stokehold to the after end of the engine room, so as to give ample light and ventilation to these compartments; and the top, from the fore end of boiler room to right aft, is entirely of steel. The wheel house is on the bridge deck, and is heavily constructed of teak. This house contains the controlling devices of the steam steering gear, the latter being placed aft on the main deck near the rudder quadrant.

The deck fittings comprise a powerful steam and hand windlass, with warping ends and the usual compressors and controlling gear fitted on the forecastle head; a steam trawl winch, fitted aft on the main deck, together with the usual arrangements for the beam and other trawling for use in the pursuit of the duties for which the vessel is intended. The steam steering gear, trawl winch and windlass were supplied and fitted by Thomas Reid & Sons, Paisley. The exhaust steam of all these is carried to the condenser. All the wood deck fittings, such as skylights, companions, and including the forecastle and quarter decks, are of teak.

VIEW FROM STARBOARD QUARTER, LOOKING FORWARD.

Two pole masts of Oregon pine, each in one length are fitted with the usual standing and running rigging. There are two boats, one 18-foot lifeboat and one 20-foot cutter. Each has a beam of 5 feet, and both are very strongly constructed of teak and pine, and have very ample outfits. The cutter is fitted with air cases similar to the lifeboat.

The bower anchors are of Hall's stockless type, three in number, and each weighing 9½ cwts. The stream anchors are 2¾ cwts., and the kedge 1¼ cwts. These are of the ordinary stock pattern. The cables are stud linked, and measure 165 fathoms, of 1 1/16 inches for the bowers, and 60 fathoms of 10/16 inch for the stream anchors. The hawsers and warps are of tarred manila.

The accommodation below deck, forward, includes four sleeping cabins, saloon, pantry, bath room and toilet. The saloon is fitted in neatly paneled, light polished oak; the sleeping cabins in enamelled pine, with polished teak toppings and nosings. Abaft the engine room are the crew's mess room, captain's, mates', engineers' and stewards' sleeping cabins, and a large and roomy laboratory for the use of the scientist for experimental work in connection with the Fishery Board's duties. The crew's accommodation is right forward in the forecastle.

A perfect system of ventilation is fitted. The whole of the cabins are heated by steam radiators, the steam being led from the main boiler and back to the condenser. A complete system of electric bells is fitted throughout the vessel. The lighting is by electricity, and includes a 5,000-candlepower searchlight, placed on the bridge. The electricity is generated by a direct-coupled steam engine and dynamo, by J. H. Holmes & Company, Newcastle-on-Tyne. A reserve set of oil lamps is also fitted, and the vessel has a complete outfit for both hull and machinery.

The *James Fletcher* is propelled by two triple-expansion three-cylinder surface condensing engines, each operating a three-bladed manganese bronze propeller. The cylinders are 10, 16 and 26 inches in diameter, and have a stroke of 20 inches; the high-pressure cylinder in each case being forward, and the low-pressure aft. Piston valves are fitted to the high-pressure and intermediate cylinders, and double ported D valves with relief rings to the low-pressure. They are all worked by Stephenson link motion, with double-bar links.

The framing of the engines is entirely of cast iron; all the principal rods, shafts and spindles are of mild steel. White metal is fitted to the bottom ends and also to the main bearings. The reversing gear is of the direct-drive steam and hand type, and the whole of the starting valves and controlling gear are handled from one position, so that the whole can be easily operated. The engines were designed to indicate not less than 650 horsepower when working at a boiler pressure of 185 pounds per square inch.

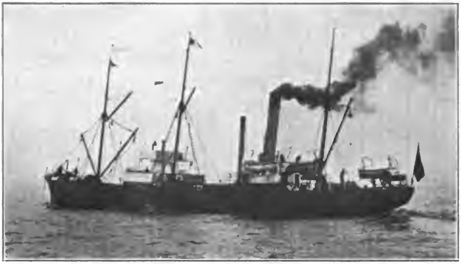
The auxiliary machinery includes an independent condenser, operated by a separate steam-driven centrifugal circulating pump. The suction branch of this pump is connected to the bilges as well as the sea, so that if necessary the bilges may be pumped out by it. A vertical direct-acting duplex donkey or general service pump, with all gunmetal water ends, is fitted; also a Weir feed heater with automatic controlling gear, operating the boiler feed pumps. These latter are in duplicate, of the duplex type, and are direct and double acting. There is also a Downie feed-water filter. The electric lighting plant and the main air, feed and bilge pumps are entirely in duplicate, and are driven direct by a compound steam engine.

LOOKING FORWARD FROM QUARTER DECK, SHOWING STEAM TRAWL WINCHES.

A complete system of piping and pumping arrangement is fitted.

The boiler is of the single-ended return tube type, with three furnaces. It is 14 feet 6 inches in internal diameter by 10 feet long, and constructed entirely of steel, in accordance with Lloyd's rules and regulations, for a working pressure of 185 pounds per square inch. It has ample heating and grate surface for its required duties. The furnaces are of the Morison suspension type, each with its own separate combustion chamber. The stokehold is forward in the ship, the back end of the boiler being against the fore end of engine room. The weight of the boiler empty is 41 tons, and with steam up 59½ tons.

The speed of this vessel on her trial trip was 12¾ knots, and the indicated horsepower 660; a result very satisfactory to both builders and owners.



THE STEAMER DYNAMO, WHICH RAN INTO AND SANK THE TRAWLER QUAIL.

Collision of the Dynamo and the Quail.

The Wilson liner *Dynamo* and the steam trawler *Quail* collided in the Humber river early on Aug. 19. The *Quail* was one of the unfortunate vessels damaged by the Russian Baltic fleet in 1904. In the present instance she was struck on the starboard side aft, and sank very rapidly. The liner sustained very little damage. Two men were drowned, but the rest were saved by the boats of the *Dynamo*.

The *Dynamo* is jointly owned by Thomas Wilson, Sons & Company, Ltd., Hull, and the North Eastern Railway Company, Ltd. Her gross tonnage is 504 and net 311. Her dimensions are: Length, 175 feet 7 inches; beam, 25 feet; depth, 13 feet 8 inches. She had a previous accident, having struck on the Jarding Rocks June 8, 1906.

THE STEAM TRAWLER QUAIL, WHICH WAS SUNK THROUGH COLLISION WITH THE DYNAMO.

The *Kaiser Wilhelm II.*, in August, steamed from Sandy Hook to Eddystone lighthouse, 3,008 nautical miles, in 5 days 9 hours 55 minutes. The speed was 23.71 knots.

A Quick Method of Repairing a Broken Shaft.

BY U. S. C. E. MEIGS.

The writer recently, almost by accident, hit on a method of repairing a broken shaft, so cheap, so quick, and so surprisingly strong that he thinks it may be of service to your readers. The use of the method would often obviate a long and expensive delay and loss of work, for the shaft gives nearly as good service as before it was broken.

The writer has under his charge a hydraulic dredge used on the Mississippi river improvements in the vicinity of Keokuk, Iowa. This dredge is driven by a compound high-pressure engine, with cylinders 14 and 24 inches in diameter by 15-inch stroke, running 220 revolutions per minute and developing about 250 horsepower. The steel shaft of this engine, 6 inches in diameter, broke about 10 inches from one of the cranks.

The cranks are quartering, and the shaft is a highly finished one that takes a long time to build, even under the

best of circumstances. It was, as you can see, a difficult task to weld this shaft so as to repair it, as the stub-end was so close to the crank that to heat it sufficiently was likely to warp the latter out of shape and spoil the whole shaft. The attempt was made, however, and the shaft promptly broke again at the same place, although a whole week and a large expense had attended the effort to put the shaft in working condition.

At the suggestion of a traveling engineer, we simply squared the two broken ends and screwed them together with a stud that went half into each piece of shaft. Squaring the ends shortened the shaft some six inches, but this could be remedied by moving in the outboard pillow block. A chunk of soft and tough steel, that had once done duty as a wristpin for a large engine, was selected from the scrap pile. This was cut off 10 inches long and turned to 4 inches in diameter; it was then threaded the whole length with a screw of four threads to the inch; each piece of shaft was then bored and threaded to fit this screw, and when finished the stud was screwed into one piece of shaft, and the other piece screwed home. To make the job a little more solid, the stud was dipped into salt and water to make a rust joint of it, and keep it from coming unscrewed by any chance.

It took an afternoon and part of the night to complete this job, and the next morning the shaft was replaced in the engine and put to work. It has never shown the least indication of weakness so far, and is still, after eighteen months, apparently as good as ever. The new shaft, ordered as a hurry job, was received in two months, but is still kept in reserve. The joint between the two pieces of shaft was fortunately an inch or so inside of the pillow block, and is now undistinguishable from the rest of the shaft. The work of the engine, of course, always tends to screw the pieces tighter together; but it seems a little surprising that the threads do not strip off and let the two pieces separate. Probably the friction between the outer parts of the shaft takes up most of the torsional strain. The 4-inch stub would not last a minute by itself.—*Scientific American.*

The New Yarrow Yard at Scotstoun, Glasgow.

The new premises, which are situated at Scotstoun, about 5 miles from Glasgow, cover an area of about 12 acres, and have a river frontage of 784 feet. The yard is on the north side of the Clyde, and is adjacent to Scotstoun West station on the Lanarkshire & Dumbartonshire Railway.

The class of work which the firm will carry on in Glasgow will be similar to that which has hitherto been carried on in London; that is, the construction of torpedo boat destroyers and torpedo boats and shallow draft steamers of all types. The firm has lately been building some high-speed motor boats, driven by internal combustion engines, which have proved highly satisfactory. The first order with which the firm started at Scotstoun was for ten torpedo boat destroyers for the Brazilian government, which are now in course of construction. One has just been launched.

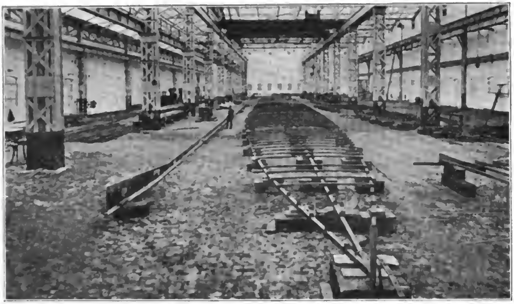
In deciding as to the laying out of the yard, good supervision and easy communication between the different departments were points to which particular attention was given.

BRAZILIAN DESTROYERS UNDER CONSTRUCTION: THE COVERED WET BASIN IN RIGHT BACKGROUND.

The general offices are situated in the center of the northern boundary, facing South street, the engineers' shops being on one side and the boiler shops on the other, and the managers of these departments being within easy distance of the general offices. The west side of the yard is devoted to the buildings connected with the engineering side of the business, and consist of machine shops, general stores, tool stores, power station, smiths' shop and pattern shop. On the east side of the yard are placed those buildings which are connected with the shipbuilding and boiler-making departments, consisting of boiler shops, galvanizing shop and platers' shed.

The launching slips occupy about 360 feet length of the whole frontage, and are inclined to the edge of the river at an angle of about 60 degrees.

To the westward of the launching slips a wet basin has been constructed. The width of this basin is 86 feet at the cope level, and the length is about 330 feet. The basin is set at an angle to the river, to facilitate getting into the basin, and also to avoid the silting up of same. The basin has been



LAYING OUT THE DECK OF A BRAZILIAN DESTROYER IN THE BOILER SHOP.
(Copyright, McClure, McDonald & Co.)

dredged out to a depth of about 14 feet at low water, so that the ships will never ground.

The engineers' shops are 210 feet long, and consist of three bays, 65, 50 and 35 feet wide. In the widest bay there is a 50-ton electric traveler on upper rails, the height from the rail face to the floor level being 40 feet, and on lower rails a 5-ton traveler. The other bays will also be equipped with electric travelers. These shops have wood block flooring.

The boiler shops are 300 feet long, and consist also of three bays, 65, 50 and 35 feet wide, the spans being similar to the engineers' shops, but arranged in different order. The wide bay has a 50-ton electric traveler, and another of 10 tons capacity. The other two bays are also equipped with electric travelers. To serve the hydraulic riveter a 10-ton electric jib crane has been fitted up. These shops have wood block flooring. The galvanizing shop forms an annex to the boiler shops.

The space between the boiler shops and the platers' shed is equipped with a 7-ton electric traveler of 85-foot span and about 330 feet in run, and it is intended that the area commanded by this traveler will be used for building boats which have to be sent abroad in pieces.

The platers' shed, 180 feet long by 90 feet wide, occupies a position near the head of the launching slips, and convenient for the punching, drilling and bending of plates. Motor-driven tools are also placed in the yard at the head of the launching slips.

The wet basin is roofed over, and the building equipped with a 50-ton electric traveler of 93-foot span, commanding the whole area of the basin. After launching the boats they will be taken into the wet basin to receive their machinery and to complete the fitting out.

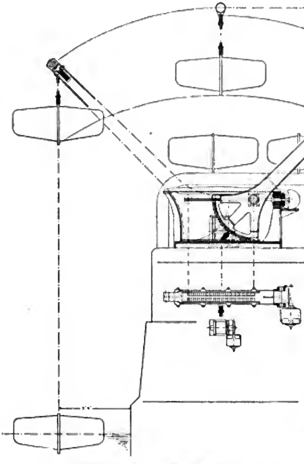
The pattern makers' and joiners' shop is 270 feet long by 45 feet wide. In this shop the machinery is arranged about the middle of the lower floor. The joiners occupy one end of the building and the pattern makers the other end, and the

WATER FRONT OF THE YARROW YARD NEAR GLASGOW, SHOWING BRAZILIAN DESTROYERS BUILDING.

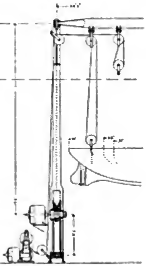
machinery will be common to both. One feature of this shop is the arrangement for driving the machinery. A pit is formed underneath the floor, and the machinery is driven by a motor placed in the pit. The motor will drive onto various lines of shafting, and belts from these carried direct to the machines, so that the belts will not in any way interfere with the working of the machines. The upper floor of this building will be used as a laying-off loft.

pick up from the railway line, which may bring machinery out from any of the shops.

The steel work has been erected by Sir William Arrol & Company. The weight of the steel work in the engineers' shop is about 725 tons, and in the boiler shop nearly 800 tons. All the shops, with the exception of the pattern shop, are constructed of steel filled in with brickwork, principally 9 inches thick.



ARRANGEMENT OF DAVITS FOR BATTLESHIP.



PLAN, SIDE ELEVATION AND END VIEW.

It is intended to equip the smithy with four steam hammers, the largest being 40-cwt. size. In this building ample provision has been made for ventilation to carry off the fumes and smoke.

The works are driven by electric power; current being supplied by the Clyde Valley Power Company. Alternating current is supplied at 400 volts, 25 cycles per second. All motors ordered for new machines, etc., are alternating current, and it was decided to bring all the existing plant from London, this including about eighty direct-current motors. In order to supply current for these a motor generator is installed, supplying direct current at 210 volts. The general lighting throughout the yard is by electricity, and it was decided to place a gas jet at each machine in the engineers' and boiler shop.

One boiler is installed, which will supply steam for the steam hammers and also low-pressure steam for the heating of the shops; otherwise all the power is electric.

The railway system in the yard is such that easy communication is given with the Caledonian main line, and also easy communication between the various shops and from the shops to the wet basin, the traveler at the wet basin being able to

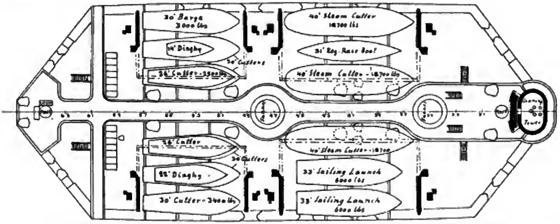
THE HANDLING OF BATTLESHIP BOATS.

It has long been the custom in the United States navy to handle boats by means of heavy cranes, operated by electric motors. In November and December of last year we illustrated and described a number of these cranes, designed for handling boats weighing up to 15 tons. The cranes were of various types and of considerable weight, the largest, with an outreach of 31 feet, weighing no less than 76,000 pounds. A later crane of this same type on the battleship *New Hampshire* is said to weight about 78,000 pounds.

A proposition has been made to the Navy Department by the Welin Quadrant Davit Company,* looking to the reduction in the weight of this sort of top hamper by the substitution of four pairs of double quadrant davits on a battleship for four of the previous cranes. The davits proposed are in two groups, heavy and light; the two heavy pairs being designed for the handling of the group of longer and heavier boats, such as the steam launches, etc.; while the two pairs of smaller davits are for the shorter and lighter boats. This grouping of the boats according to size and weight is for the purpose of utilizing to the best advantage the davits proposed.

The lifting capacity of the heavier davits would be 20,000 pounds, with the quadrant frames spaced 42 feet 6 inches apart; the lifting capacity of the smaller davits would be 4,000 pounds, with the quadrant frames spaced 32 feet apart. The total weight of each pair of the larger davits, with all apparatus, is approximately 24,000 pounds; while that of the smaller davits is 9,000 pounds. The total weight of the four sets complete is thus 66,000 pounds. This is seen to be much less than the weight of a single one of the very large cranes now employed for this purpose; and it is estimated that a total saving of about 100 tons would be effected in the top weights of a large battleship by the substitution here outlined.

* No. 17 Battery place, New York, and 5 Lloyd's avenue, London, E. C.

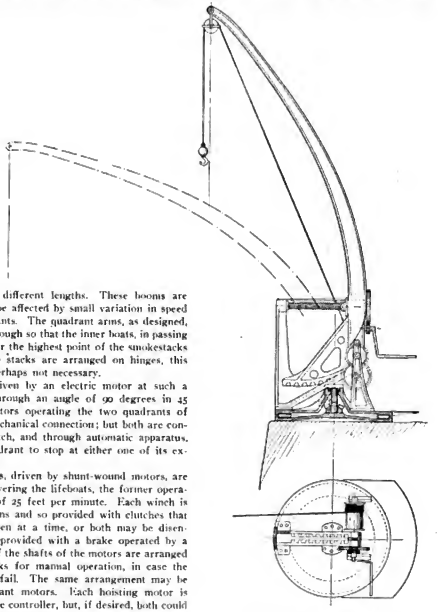


BRIDGE DECK OF THE BATTLESHIP KEARSARGE, SHOWING PROPOSED ARRANGEMENT OF WELIN QUADRANT DAVITS.

The two davits in each pair are joined at their upper ends by a steel boom, to which are secured tackles suitably arranged for handling boats of different lengths. These booms are arranged so as not to be affected by small variation in speed between the two quadrants. The quadrant arms, as designed, have been made long enough so that the inner boats, in passing over the outer, will clear the highest point of the smokestacks of a launch. As these stacks are arranged on hinges, this extreme clearance is perhaps not necessary.

Each quadrant is driven by an electric motor at such a speed that it moves through an angle of 90 degrees in 45 seconds. The two motors operating the two quadrants of each pair are not in mechanical connection; but both are controlled by a single switch, and through automatic apparatus, which causes each quadrant to stop at either one of its extreme positions.

Two hoisting winches, driven by shunt-wound motors, are used for lifting and lowering the lifeboats, the former operation being at a speed of 25 feet per minute. Each winch is equipped with two drums and so provided with clutches that one drum may be driven at a time, or both may be disengaged. Each drum is provided with a brake operated by a foot lever. The ends of the shafts of the motors are arranged for the fitting of cranks for manual operation, in case the electric supply should fail. The same arrangement may be installed on the quadrant motors. Each hoisting motor is provided with a separate controller, but, if desired, both could be controlled by a single switch, and through automatic starting apparatus, while the small changes in relative speed which might be necessary could be effected by means of a rheostat,



PIVOTED DIFFERENTIAL-TYPE DAVIT.

arranged to change the strength of the field of one of the motors, so as to either increase or decrease the speed of that particular motor. All of the motors would be designed to run without sparking, and, by reason of the intermittent and occasional character of their service, they would also operate without heating.

The drawing, showing the general arrangement of the quadrants to be operated through 90 degrees, makes provision for placing three boats side by side, and handling them all from the same set of apparatus. As figured out for one of the smaller battleships, this particular outfit gives an outreach at the waterline of 7 feet 3 inches from the side of the ship. The radius of the quadrant running in the rack is 4 feet 2 inches, while the radius of the long arm of the davit is 19 feet 2 inches. The davit arm is made of either cast or structural steel, while the framework is of cast steel.

The arrangements of these davits on the boat deck of a battleship of the *Kearsarge* type is shown in another drawing, where the space taken up by the framework and motors is shown in black, the extreme inward position of the davits being given by dotted lines. This arrangement is for the handling of sixteen boats, varying from a 14-foot dinghy to three 40-foot steam cutters weighing 18,700 pounds each. These latter are not up to the limit of the outfit as designed, but they represent about the heaviest type of boats used for this purpose.

Alternative proposals have been made, looking to the use of swinging davits with differential gear so arranged that at maximum outreach the power arm is also at a maximum. This is provided for by placing the rack at an angle, and so adjusting the curvature of the quadrant as to fit that rack at all positions.† These swinging davits would be pivoted and run upon a combination of roller and ball bearings, and would be operated to a certain extent in the same manner as the present cranes. They would, however, have the advantage possessed by the other davits of this type in being run out and in by the usual screw, and with considerable celerity. They would have the further advantage of being able to pick up a boat at any point within their radius, by virtue of the fact that the position of the upper sheave can be adjusted by a combination motion between the pivot and the traversing thread. In this case, of course, only a single davit would be used, in place of the pair provided for in the other proposition.

† See also page 61, International Marine Engineering, February, 1908.

Head-on Collision in Kaiser Wilhelm Canal.

The illustrations show the effect of a head-on collision which happened on June 16 in the Kaiser Wilhelm canal. Both steamers were going at low speed, and when they tried to clear each other, the steamer *Stadt Schleswig* did not obey the rudder. The pilot ordered full speed ahead in order to get steerage way, but it was too late to avoid collision. The *Schleswig* struck the steamer *Skelleftea* on the starboard bow, and while she lost her anchors (the broken shaft can be seen in the hawse pipe) and bent her bow, she also inflicted severe injuries to the *Skelleftea*.

Russian Armored Cruiser Amiral Makaroff.

BY JOSEPH G. PELTIER.

This cruiser is the only big ship built in France in 1907 for foreign account. She is the first of three new armored cruisers for the Russian navy; the two other boats being in course of building in the national dockyards in the Baltic. They are virtual reproductions of the *Bayan*, now the *Aso*, of the Japanese navy.

This cruiser has the following particulars:

	Meters.	Ft.	Ins.
Length between perpendiculars	135	443	..
Breadth at the waterline	17.50	57	5
Breadth at the height of the upper deck	17.56	57	8
Depth from main deck	11.60	38	1
Mean draft	6.51	21	5
Displacement in tons			7,877
Indicated horsepower, designed			16,500
Speed, designed, knots			21

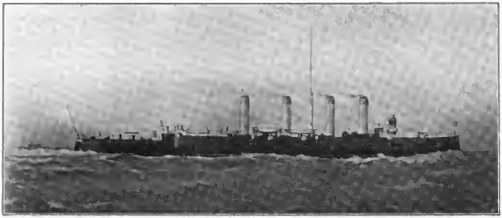
HULL AND GENERAL PROTECTION.

The hull is of steel throughout, and fitted with bilge keels and docking keels. It is protected by an armor belt of Krupp special steel. The heavy strake of this armor is worked from stem to stern; the second strake above this is worked from stem only to the after casemates. The heavy strake has a total height of 1.8 meters (5 feet 11 inches), of which only 60 centimeters (2 feet) are above the waterline; this strake is 175 millimeters (6.9 inches) in thickness amidships and only 100 millimeters (3.9 inches) at the stem and stern; the second strake is worked up to the main deck; its thickness is of 100

STADT SCHLESWIG.

SKELLEFTEA.

SKELLEFTEA.



THE RUSSIAN ARMORED CRUISER AMIRAL MAKAROFF ON TRIAL TRIP.

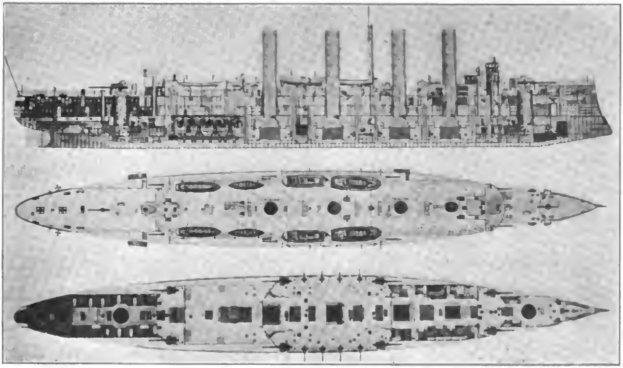
millimeters (3.9 inches) amidships and 80 millimeters (3.2 inches) at the ends. There is a protective deck, worked at the height of the upper edge of the main strake; this deck is protected with chrome-nickel plates supplied by Krupp. These plates are 50 millimeters (2 inches) thick on the slope and 30 millimeters (1.2 inches) on the flat.

The total weight of the armor belt, turrets and casemates, all protected, is equal to 23 percent of the displacement of the cruiser, or 1,810 tons. The hull is protected by a cofferdam running from end to end and behind the belt side armor. There are two conning towers, one ahead, one aft. The forward one is 136 millimeters (5.4 inches); the other one is thinner. Both are of Krupp special steel.

ARMAMENT.

The battery is composed of two 8-inch breech loading rifles; eight 6-inch rapid fire guns; twenty 3-inch and 3-pounder rapid fire guns, and four Maxim machine guns. The 8-inch guns are located in two axial turrets, one forward, one aft. They are protected by 150-millimeter (5.9 inches) Krupp steel on both turret and barbette. The 6-inch guns are located four on each side, in four casemates. At the center there is a special citadel, which also contains four 3-inch guns on each side; therefore, these small guns are well protected. The casemates and this citadel are protected by an outside plating of 100 millimeters (3.9 inches), worked up to the weather deck. There are also two submerged torpedo tubes for 450-millimeter (18-inch) torpedoes.

The fire will consist of, forward or aft, one 8-inch, four 6-inch; and the broadside fire of two 8-inch guns, four 6-inch guns and ten 3-inch guns. These guns have the following caliber: 8 inches, 45 calibers; 6 inches, 45 calibers; 3 inches, 52 calibers. The 8-inch guns are able to deliver three shots per minute. According to the lessons of the last war and the destruction of the French battleship *Iena*, the shell and powder rooms have been built with all possible care; there are air



INBOARD PROFILE, WEATHER DECK AND GUN DECK OF THE ARMORED CRUISER AMIRAL MAKAROFF.

bulkheads in the parts adjacent to boiler, engine or dynamo rooms. All turrets, shell hoists, pumps, ventilators, steering gear, etc., are electrically driven. As far as possible wood has been prohibited in the fitting of this vessel; the main part of the furniture is made of metal. For the first time in France there has been used the Wikström composition as deck fitting instead of linoleum. This composition is fireproof, and seems at first sight to be of cement.

MACHINERY.

The cruiser is fitted with two main engines, located in two watertight compartments. They are of the triple expansion, four-cylinder type, and drive each a propeller. The steam is supplied to the main and auxiliary engines by twenty-six boilers of the Belleville type, fitted with economizers. These boilers are located in four watertight compartments, divided into eight boiler rooms.

The usual bunkers have a total capacity of 1,050 tons, which, according to the trial figures, give a radius of nearly 7,750 miles at the cruising speed of 14 knots. The contract figure was only 7,000 miles at this speed.

TRIALS.

Consumption Trial for Six Hours.

	Trial.	*Contract.*
Indicated horsepower	3,300	......
Consumption per hour and indicated horsepower, kilogram	0.535	1
Full Power Trial for Three Hours.		
Indicated horsepower	19,615	16,500
Speed, knots	22.55	21
Admiralty coefficient	231	222

At the cruising trials at 14 knots speed the mean consumption for twenty-four hours was only 0.839 kilogram. These figures show the good qualities of both hull and boilers and machinery.

The original *Bayan*, also built at La Seyne, was noted as an unusually successful vessel. On trial she exceeded her contract speed by 1 knot, making 22 knots with 17,400 horsepower (Admiralty coefficient, 239). The coal consumption was only 1.4 pounds per horsepower per hour. On full power, in service, she burned about 14 tons per hour.

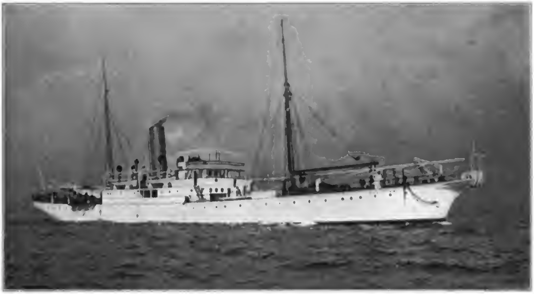
The Cable Steamer Guardian.

The *Guardian* is a twin-screw cable-repairing steamer, which has been specially built for the Central and South American Telegraph Company, of New York, to look after its extensive submarine cables in the South Pacific, where her headquarters will be at Callao.

Swan, Hunter & Wigham Richardson, Ltd., her builders, have had considerable experience in building cable-laying and cable-repairing steamers, and this, added to the owners' special knowledge of their requirements, have combined to make the *Guardian* one of the most complete and up-to-date steamers that has yet been built for cable-repairing work.

The dimensions of the ship are: Length over all, 293 feet; length between perpendiculars, 270 feet; breadth, 36 feet, and depth molded, 24¾ feet. At Lloyd's load draft she has a total deadweight capacity of over 2,400 tons.

She is fitted with twin-screw triple-expansion engines, with cylinders 15½, 25 and 43 inches in diameter by 30-inch stroke, and two large boilers fitted with Howden's forced draft. The hull, as well as the engines and boilers, have been built at the Neptune Works. When loaded under service conditions at a draft of 18 feet mean, the vessel easily maintained a speed of over 12½ knots on trial trip.



THE CABLE STEAMER GUARDIAN AT SEA.

One special feature is the unusually large bunker capacity, which is such as to enable the vessel to keep at sea for about forty-five days when cruising at a speed of 10 knots (10,800 nautical miles). She has large water ballast and fresh-water capacity.

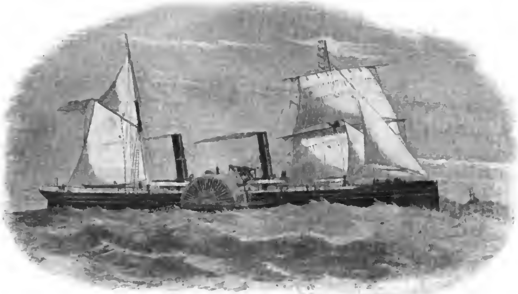
The vessel has four cable tanks with steel cones. The two largest of these cable tanks have each internal tanks, making six coiling tanks in all. The cable machinery for picking-up and paying-out is of Johnson & Phillips latest type. The testing room, which is at the fore part of the bridge, is a large, well lighted, comfortable room, fitted in polished mahogany, with a special battery room adjacent to it.

Comfortable, well-fitted accommodation for the captain, electricians, officers and engineers is provided on deck amidships, with saloon in polished oak, below the spar deck aft. The accommodation for the petty officers, cable hands, sailors and firemen is on the main deck.

The vessel has teak weather decks, and is provided with a steam capstan windlass, two steam winches, and steam and hand steering gear, also all necessary appliances for lifting and

stowing buoys, etc. She has six boats, including a motor launch. There is electric lighting throughout, with a searchlight placed on the captain's bridge. Refrigerating rooms are fitted for provisions, with machine of the CO_2 type, made by J. & E. Hall, London. Among other special fittings there is a Lucas deep-sea sounding machine.

the two paddle wheels were operated by separate engines, and that either could be run alone, or both at differing speeds. This must have been of great assistance in maneuvering. The vessel was used for some time in 1854 in connection with steamers on the Pacific in a service between New York and California by way of the Isthmus of Panama.



COMMODORE VANDERBILT'S STEAM YACHT NORTH STAR, BUILT IN 1852.

The North Star.

"This splendid specimen of American naval architecture has proved one of the most perfect-modeled steamers, for safety and speed, afloat. In her first trip she crossed the Atlantic in *ten days and eight hours*. Her owner, Commodore Vanderbilt, is a merchant prince and shipbuilder of New York. She is a paddle-box steamer, with two funnels, and registers 1,876 tons; she is capable of carrying 2,500 tons. She is 260 feet on the keel, 270 feet on the spar deck, 38 feet breadth of beam, 13 feet from floor timber to lower deck beams; 7 feet 8 inches between decks, 7 feet 6 inches between spar decks, making her whole depth 28 feet 6 inches. She has four boilers, which are 24 feet long, 10 feet diameter; the engines are upon the same principle as those used in our ordinary river steamboats. Handsome flights of stairs lead to the saloon, which is larger and more magnificent than the saloon of any ocean steamer afloat. Ranged around the saloon are beautifully furnished cabins, the doors and panels of solid bird's-eye maple and rosewood. Mirrors extending from the ceiling to the floor are fixed in the cabins. The walls are imitative marble and malachite, formed of a conglomerate of marble stone and glass—a recent American invention. It is fixed on wood peculiarly seasoned, and bears an exquisite polish. The *North Star* cost some $500,000, and her weekly expenses are about $1,700, exclusive of fuel. Everything on board is American. Surprise has been expressed at the small quantity of fuel consumed on board the *North Star*, when her speed is considered. In her passage across the Atlantic she consumed only fifty tons of coal a day, while the consumption ordinarily in such steamers is from seventy-five to one hundred tons daily. She has been enabled to traverse the ocean at so little expense by her being driven by what is called a beam engine—an American invention, which has never before been used in a steamer to cross the Atlantic."—*Gleason's Pictorial Dollar Weekly*, 1852.

Editor's Note.—Examination of the illustration shows that the two paddle wheels were operated by separate engines, and that either could be run alone, or both at differing speeds.

The illustration and information were furnished us by William McAllister, City Island, N. Y., who, as a youth, was employed in the construction of the yacht. She was built by J. Simondson, at foot Eighteenth street, East River, New York; and engined by the Allaire Iron Works, New York.

Two huge battleships were launched in British shipyards Sept. 10. One was the *St. Vincent*, the largest and heaviest of British warships, launched from the government yard at Portsmouth. Her dimensions are as follows: Length between perpendiculars, 500 feet; beam, 84 feet; draft, 27 feet; displacement, 19,250 tons. The engines will be of 24,500 horsepower, and a speed of 21 knots is expected. The ship will be armed with ten 12-inch guns and a secondary battery of twenty 4-inch guns. The other vessel was the Brazilian battleship *Minas Geraes*, launched from the yards of Sir W. G. Armstrong & Whitworth, at Elswick, on the Tyne, a bigger and more powerful ship than the *St. Vincent*. She has a displacement of 20,000 tons, and is 530 feet in length, though she draws 25 feet only instead of 27. In armament she is superior to the *St. Vincent*, as she has twelve instead of ten 12-inch guns, and can bring all of them to bear on either broadside,* while the *St. Vincent* can bring only eight to bear. The secondary armament consists of twenty-two 4.7-inch guns. She is the first of three ships of this type. The *St. Vincent* is also the first of three, being a development of the *Dreadnought*. The main difference between the two ships, aside from the fact that the *St. Vincent* has Parsons turbines and the *Minas Geraes* reciprocating engines, lies in the arrangement of battery. The Brazilian has one extra turret (two 12-inch guns) forward, so mounted as to fire over its mate. The two waist turrets are moved further aft; and the turret next the last is raised to fire over the after turret.

*There seems to be a little doubt on this point, but it is certain that ten, at least, can be so concentrated.

INTERNATIONAL MARINE ENGINEERING

Published Monthly at

17 Battery Place New York

By MARINE ENGINEERING, INCORPORATED

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President

E. L. SUMNER, Secretary

and at

Christopher St., Finsbury Square, London, E. C.

E. J. P. BENN, Director and Publisher

SIDNEY GRAVES KOON, Editor

Branch Offices { Philadelphia, Machinery Dept., The Bourse, S. W. Anness. Boston, 170 Summer St., S. I. Carpenter.

Entered at New York Post Office as second-class matter.

The edition of this issue comprises 6,000 copies. We have no free list and accept no return copies.

Shipbuilding.

The whole situation is very discouraging. Lloyd's report, for the quarter ended June 30, 1908 (figures for the September quarter are not yet at hand), shows a total gross tonnage under construction in Great Britain of only 799,178, as compared with 1,250,318 gross tons in hand a year ago. This represents a reduction of 451,140 tons, or more than 36 percent. It is the lowest total recorded by Lloyds since 1896.

Various causes are given for this state of affairs, the shipbuilding strike having apparently something to do with it, but it seems to be more generally conceded that the basic cause lies in over-production. The calendar years 1906 and 1907 were the two largest in the history of British shipbuilding. The former was a record by long odds, and the latter fell comparatively little short of it. It would appear, on the face of the returns, that the enormous output of these two years has not by any means been absorbed by the requirements of the business. When to this over-production we add the fact of a very sharp decline in general business, beginning about a year ago and not yet entirely over, resulting in a reduction in commercial transactions and, consequently, in the movement of freight by water as well as by rail, it is not at all surprising that dozens of ships are tied up idle in British and continental ports, and that the new work in hand has fallen off so decidedly.

In the United States the depression is probably much more marked than in Britain. The report for the month of August of the Bureau of Navigation in Washington showed the construction in that month in the United States of *no less than five steel steamers, with an aggregate of* 514 *gross tons.* Wooden vessels propelled by steam and sail brought these figures up to 125 and 4,583, respectively, but it is only the steel steamer that counts to the fullest extent in a return of this sort. It would thus appear that the shipbuilding industry of the United States is fast approaching the vanishing point. In addition to the general industrial depression, other contributory causes are found for American shipbuilding depression in the fact that, with the high wages prevailing in American shipyards, competition against British, and particularly Scotch, shipbuilders is totally out of the question These wages are slightly lower, perhaps, than those prevailing in similar lines of work in other industries in the United States, so that a further lowering of this item would cause labor to shun the shipyard district entirely, and the vanishing point would then be right at hand.

For some years an agitation has been carried on in the American Congress looking to the institution of some artificial means of equalizing matters as between the cost of constructing and operating ships in the United States and under American laws and the cost of constructing and operating ships under European conditions. Preferential tariffs, favoring the American-built and operated vessel, have been advocated in some quarters; and violently opposed in others. A direct bounty, or subsidy, to American-built and operated ships on certain specified routes and fulfilling certain conditions as to speed, frequency of voyages and the carrying of cadets, has four times been brought directly before Congress; and each successive time it has been defeated by a margin smaller than the preceding. It is to be under consideration again this winter, and those are not wanting who believe thoroughly that it will be put into effect.

Some critics of this scheme advocate "free ships" for America, meaning the admission to American registry of any ship whatsoever, wherever she may have been built. This would scarcely add to the business of American shipbuilders, and it should be noted here that the problem as a whole is two-headed—the

problem of the shipbuilder and the problem of the operator, and neither one is to be solved at the expense of the other. Free ships might help the latter, but would be ruinous to the former, if a business already well-nigh killed can undergo further ruination.

The Fighting Values of Warships.

A German authority has contributed to a recent number of *Schiffbau* a study of the values of the principal warships of the world, based upon an arbitrary formula which he has devised, and which takes account of the various offensive and defensive features of each individual ship. Some of the results obtained are more or less startling, for he gives the *Michigan* of the American navy a value of 85, as against a value of 80 for the *Satsuma*, 77.1 for the *Dreadnought* and sisters, 70.2 for the *Nassau*, 66.7 for the *Lord Nelson* and 65 for the *Danton*. After giving in detail the figures for twelve battleships and ten armored cruisers, he proceeds to take up the types of ships in the various navies, and to give totals for battleships and large cruisers, and for the entire fleets. In these latter figures it is interesting to note that he has given the American *Delaware* class a value of 100; the *Invincible*, 77; the new 20,800-ton Japanese ships, 90; and the new Russian designs of 22,000 tons a value of 90.

Without going into the detail in which the figures are given, we may recapitulate his final results as follows:

Navy.	Ships.	Displacement.		Fighting Value.		
		Total.	Average.	Total.	Average.	Per Million Tons
Great Britain	144	1,736,270	12,057	2,057	14.3	1,185
United States	46	593,190	12,895	1,179	25.63	1,988
France	69	728,900	10,564	1,087	15.75	1,491
Germany	43	507,890	11,811	884	20.55	1,740
Japan	31	399,710	12,894	788	25.41	1,971
Russia	29	334,440	11,532	538	18.5	1,609
Italy	26	276,420	10,632	185	7.12	670
Austria	14	104,420	7,459	100	7.15	957

It is seen that the United States is given the largest average fighting value, with Japan a close second and Germany third. Even Russia and France are placed ahead of Great Britain. This is due largely to the inclusion in the British figures of such old vessels as the *Collingwood*, *Colossus*, etc., which have already been sold for old iron. The British figure is also brought low by the inclusion of several cruisers of the *Arrogant* and similar classes, while the more powerful cruiser *Olympia* is omitted from the American figures, with corresponding benefit to the American average. It is interesting to note that the *Arrogant* class is given a credit of only 0.2 point. As there are included twenty-nine British cruisers with less than one point credit each, this readily explains the low British average. The high Russian average is due to the inclusion of two battleships of which the keels have not yet been laid, while only four British *Dreadnought* type battleships are shown, the three of the *St. Vincent* class, one of which is already in the water, being entirely ignored, as is also the American *New Hampshire*, now some time in service.

As illustrating the tremendous advance in the power of naval ships during the last ten or twelve years, it may be noted that the famous *Oregon* of Spanish War fame is credited with 13.13, as compared with 100 for the *Delaware*.

The "two-power" standard is being maintained against all but a combination of France and the United States, which shows 2,266 points to 2,057 for Great Britain. The Anglo-Saxons have 3,236 points, against 1,625 for the old Franco-Russian entente; 1,169 for the "Dreibund"; and 2,794 for the five continental powers combined.

Warships under Construction.

A contemporary lists in each number the principal warships being built for the various naval powers. The lists given in the September number form interesting food for thought.

Germany is shown to have under construction nine battleships, three armored cruisers and six scouts, with an aggregate displacement of 226,400 tons. Great Britain is second, with ten battleships, one armored cruiser and two scouts under construction, the displacement being 215,800 tons. The third power is France, with six battleships and four armored cruisers, accounting for 163,582 tons. Italy stands fourth, with five battleships and five armored cruisers, amounting to 126,875 tons.

Of the powers with less than 100,000 tons under construction Japan is first, with five battleships and one scout, a total of 92,100 tons. Russia is next, with four battleships, two armored and one protected cruisers, accounting for 81,150 tons. The United States comes third, with four battleships aggregating 72,000 tons. Brazil has three battleships and two scouts, amounting to 64,750 tons; while Austria has three battleships and one scout aggregating 47,000 tons.

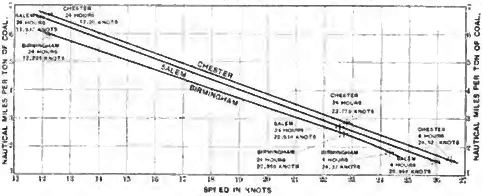
The nine powers are building no less than forty-nine battleships, fifteen armored and one protected cruisers and twelve scouts, with a total displacement of 1,089,657 tons. The British traditional two-power standard would appear to be in danger; for not only is Britain building less than France and Germany combined, but less than Germany alone. It may be stated in this connection that the British figures include all four of the *St. Vincent* class, one of which is in the 1908 program, as well as the fourth of the *Indomitable* type. Similarly the German figures include three battleships and one battle cruiser to be laid in 1908. The figures would, therefore, appear to be entirely contemporaneous.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States Navy:

	Tons.	Knots.		Aug. 1.	Sept. 1.
BATTLESHIPS.					
South Carolina	16,000	18½	Wm. Cramp & Sons	55.	58.1
Michigan	16,000	18½	New York Shipbuilding Co	60.4	65.1
Delaware	20,000	21	Newport News S. B. & D. D. Co.	35.3	40.5
North Dakota	20,000	21	Fore River Shipbuilding Co	45.7	50.1
TORPEDO BOAT DESTROYERS.					
Number 17	700	28	Wm. Cramp & Sons	28.7	40.3
Number 18	700	28	Wm. Cramp & Sons	35.7	46.7
Number 19	700	28	New York Shipbuilding Co.	42.2	47.9
Number 20	700	28	Bath Iron Works	14.	20.1
Number 21	700	28	Bath Iron Works	14.	20.1
SUBMARINE TORPEDO BOATS.					
Number 13	—	—	Fore River Shipbuilding Co	51.9	55.7
Number 14	—	—	Fore River Shipbuilding Co	51.9	54.5
Number 15	—	—	Fore River Shipbuilding Co	50.9	54.1
Number 16	—	—	Fore River Shipbuilding Co.	51.1	53.8
Number 17	—	—	Fore River Shipbuilding Co.	42.4	48.2
Number 18	—	—	Fore River Shipbuilding Co.	41.8	47.9
Number 19	—	—	Fore River Shipbuilding Co.	41.3	46.8

Regarding the difference in displacement, the contract stated that the ships were to be run at not over 3,750 tons; but any saving in machinery weights was to be allowed to benefit the contractor. The *Chester* turbine weights aggregate 155 tons, as compared with 204 tons in the *Salem*. The heaviest rotor in the *Chester* weighs 10.2 tons, as compared with 72 tons in the Salem. With regard to this last item, however, it should be noted that the *Salem* has only two rotors, where the *Chester* has six. PARSONS.



CURVES FOR SCOUT CRUISERS, SHOWING NAUTICAL MILES PER TON OF COAL AT VARIOUS SPEEDS.

Steaming Radius of Scout Cruisers.

Editor INTERNATIONAL MARINE ENGINEERING:

Your assumption on page 389 of the September number that the power (and, consequently, coal consumption per hour) at high speeds of the *Salem, Chester* and *Birmingham* varies as the cube of the speed is scarcely correct, because at these high speeds the index to the power would be considerably greater than the cube. The better way would be to plot the curve, and take the nautical miles run per ton of coal at corresponding speeds of each ship. With this idea in view, a curve has been plotted, with speed in knots as abscissæ, and nautical miles run per ton of coal as ordinates. This curve shows for each ship a definite spot at about twelve knots, another at about 22½ knots, and a third at full speed, varying from 24.32 knots in the case of the *Birmingham* to 26.52 in the case of the *Chester*.

If, now, we take from this curve the nautical miles run per ton of coal for the three ships at any desired speed, the radius of action can readily be figured from the assumed bunker capacity. Taking these figures for the full speed of the *Birmingham* and of the *Salem*, we find the following results:

At 24.32 knots.	*Birmingham.*	*Chester.*	*Salem.*
Nautical miles per ton	1.822	2.28	2.1
Radius on 950 tons	1,730	2,165	1,996
At 25.946 knots:			
Nautical miles per ton	....	1.73	1.51
Radius on 950 tons	....	1,643	1,434

These would seem to show that at 24.32 knots the *Chester* has a radius 25 percent better than the *Birmingham*, and 11½ percent better than the *Salem*. At 25.946 knots the *Chester's* advantage over the *Salem* appears to be 14½ percent.

ENGINEERING SPECIALTIES.

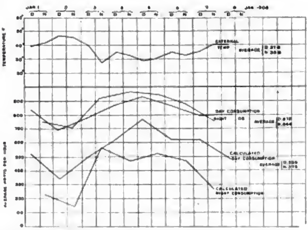
A Heat-Regulating Device.

A new electric thermostat has just been placed on the market by the Geissinger Regulator Company, 203 Greenwich street, New York, which is entirely different from any of the heat-controlling devices at present in use, and is said to possess some very marked advantages over all of them; the greatest of these being that it is absolutely unaffected by vibration. It will stand being knocked about or hammered without being put out of commission, and will operate equally well on the counter of a fast steamer or on a railway train.

Dr. Geissinger hit upon an extremely simple, clever and effective method based on the principle that, in a very flat arc, a shortening of the chord causes a correspondingly

greatly increased lifting of the arc at the center. In accordance with this principle, the thermal element consists of two metals having a considerable difference of expansibility; say, zinc and steel, but other metals may be used. We show a diagrammatic view of the thermal element in elevation and section, as used in the regulation of heat in steamship staterooms. The zinc in this case is the rigid portion of the element, so to speak, and is of a U section; the steel or flexible portion being in the form of a light steel spring carried between V-shaped steel holders, one of which is made adjustable. The contact point is of platinum, and placed at the center of the spring.

It will be seen that an almost infinitesimal reduction in the length between the V-shaped holders, due to a fall in temperature, will cause a considerable upward or outward movement of the spring at the platinum contact point, causing it to come in contact with another point fixed on the frame of the instrument, so closing an electric circuit operating a specially designed switch, which, in its turn, closes the heater circuit. A peculiar feature of this arrangement of spring is that when the contact closes it does so with a definite pressure of about 4 ounces. This is sufficient to press out all dust or other

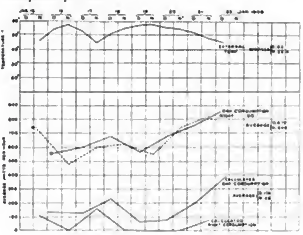


foreign matter, and, together with all absence of vibration, accounts in a large measure for the fact that after continual working for over two years the contact points show no signs of oxidization. It is hardly necessary to point out that, when the temperature increases, the reverse action takes place, the heater being thrown out of action.

So sensitive is the element, when unprotected by a casing, that the heat of the hand or of the breath is sufficient to break the heater circuit. If an incandescent lamp be substituted for the heater it is possible, by breathing on the thermostat, to produce the peculiar phenomenon of blowing out an electric lamp.

Many uses to which this thermostat can be applied will at once suggest themselves, such as, in addition to controlling the temperature of staterooms, the controlling of temperature in refrigeration tanks and holds in meat-carrying steamers, the maintaining of a definite temperature in the shell rooms and magazines of battleships, by controlling the action of the refrigerating machinery used for cooling the same. In this case the electric portion of the instrument is entirely outside the magazine. The company is now perfecting the application of the instrument to the regulation of steam heat, which, when completed, will enormously increase its field of usefulness.

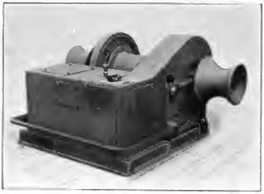
The thermostat, as designed for use in staterooms, is fitted with two thermal elements, either one of which may be set to a given temperature independently of the other. This arrangement enables one element to be set at whatever day temperature the occupant of the room requires; the other, to the desired night temperature. The placing of a three-point switch is all the occupant of the room requires to get day or night temperature, or no heat at all. This arrangement precludes the necessity of any tampering with the instrument by incompetent persons.



As an example of the saving to be effected by the use of the instrument in controlling the heating current in steamship staterooms electrically heated, the appended charts of observation taken on board the *Oceanic* will be of interest. It will be seen that with the regulation of the heat under the control of the passengers themselves, the amount of current used was nearly as great with a mean atmospheric temperature of 53° F. as when the mean temperature was 16 degrees lower. The lower curves on the charts show the amount of current that would have been required had every room been controlled by a Geissinger thermostat, the difference between the two voyages in this case being most apparent. The saving in current would have amounted to nearly 50 percent, based on maintaining a day temperature of 70° F. and a night temperature of 64° F. The saving in expense, taken for the seven months when heat is desirable, and based on one hundred heaters, would be $1,225 (£252).

An Electric Winch.

The winch illustrated is placed on the market by Chambers, Scott & Co., Motherwell, near Glasgow, and is said to be characterized by both speed and economy in handling loads. It is designed for cargo purposes, and is both more silent and efficient, as well as easier to work, than the ordinary steam winch. The arrangement in general resembles existing types of cargo winches, with a center drum and warping ends. The



details of parts and methods of working, however, are quite different.

A box sole plate carries all the parts, the gear being mounted on two standards, with the motor at the rear, and with provision made for fastening the whole to the deck. The main drum is provided with a clutch and powerful foot treadle brake, so that lowering can be effected very rapidly without current; the warping ends during such an operation remaining stationary. The gearing, motor control apparatus and cables are located in built-in steel covers, for protection from the weather. When used for warping, absolute control is assured by the operating gear and the drums, which are placed entirely clear of the body of the winch, are fitted with electric brakes, and are automatically held by the magnetic brake when the controller is in the "off" position.

An Improved Adjustable "S" Pipe Wrench.

This wrench is a new product of the Billings & Spencer

Company, Hartford, Conn., and in general design it follows the lines of their regular adjustable "S" wrench; but it has a serrated jaw for use on pipe. Every part is a drop forging from steel, and the jaws are hardened. The sliding jaw is fitted in a double groove, which greatly adds to the strength of the tool. The patent thumb screw on the adjusting nurl securely locks the jaw at any desired opening.

The wrench is made in three sizes, 6, 8 and 10 inches. It is of careful workmanship throughout, and its design is such as to make it very useful in confined places, where an ordinary wrench would be inconvenient.

Another Revolution Counter.

An instrument placed on the market by Schuchardt & Schütte, 136 Liberty street, New York, will register from zero to 10,000 in either direction, and will then repeat. It can be easily set to zero from any number. The digits are lined

up in a row for direct reading, doing away with the often puzzling use of a pointer and dial. For adjusting, a pinion with small toothed wheel at the back of the counter is screwed into a hole marked "*R*," or another marked "*L*." If set at *R* it must be used only for recording right-hand revolutions, and similarly for *L*. A number of arrangements are provided for arbitrarily setting the register at any desired figure or at zero, which could best be appreciated by trial.

TECHNICAL PUBLICATIONS.

Deutscher Schiffbau, 1908. Edited by Prof. Oswald Flamm, editor of *Schiffbau*. Size, 8 by 11½ inches. Pages, 230 + xx. Figures, 239. Berlin, S. W., 68: Carl Marfels Company. Price, 3 marks (paper covers).

This is a review, not only of German shipbuilding in 1908, but of the development of the industry throughout a long period of years. It is divided into thirteen chapters, covering, respectively, the development of the German fleet; the modern construction and the future of piston engines; the steam turbine in the propulsion of ships; the development and present position of marine boiler and engine construction in Germany; marine gas engines; technical education in ship construction; the relation of the German iron and steel industry to shipbuilding; shipyards; cranes in German shipbuilding; the German shipbuilding industry; general view of the principal laws and classification of merchant ships; electric outfits, and ships' equipments and fittings. Each of these chapters is by a separate author, himself a specialist along the line covered.

The illustrations consist of both half-tones and line cuts, the latter being apparently very good zincs. They are scattered with considerable profusion throughout most parts of the text, and include a great variety of subjects, from exterior views of ships and boats of various classes to sections of these vessels, propelling engines, steering gear, manufacturing plants, ships' auxiliaries and the thousand and one things that go to make up the structure and outfit of a modern merchant or war vessel. In the last chapter are found anchor chains, two illustrations of Welin quadrant davits, submarine signals, Clayton fire extinguishing apparatus, refrigerating outfits, etc. The work is splendidly gotten out, and gives a very good idea of the German shipbuilding industry in all its branches.

Marine Engineering: A Text-Book. By Engineer-Commander A. E. Tompkins, R. N. Size, 5⅞ by 8¾ inches. Pages, 812. Figures, 403. London and New York, 1908: Macmillan & Company. Price, 15/- net and $4.50 net.

This is the third edition of the work which has been entirely rewritten and largely expanded. There are many new illustrations and ten new chapters; the thirty-five present chapters being grouped into ten sections, covering, respectively, the introduction, which is so developed as to cover the syllabus used in the naval training establishments; marine boilers; combustion; the marine reciprocating engine; the condenser and feed-water systems; steam; propulsion; auxiliaries; care and management; and recent developments, including the steam turbine and the explosive engine.

Very little space is devoted to obsolescent types of boilers and machinery, but the thermodynamics of steam is more fully developed, so as to cover the requirements of the sea-going engineer. Every effort has been made to explain matters in as simple a manner as possible, without overlooking the practical application of mathematics as an essential to the design and economical working of marine machinery. The illustrations are mainly zinc drawings of the numerous and varied pieces of mechanism described, as well as diagrams and charts showing the expansion of steam, the operation of valve gear and the many features of marine engineering usually treated in such a book.

The main new features of interest are naturally the last two chapters, relating, respectively, to the marine steam turbine and the internal combustion engine. In the former case nearly the whole chapter is devoted to the Parsons turbine and its various applications on shipboard. Brief attention is given, however, to the Curtis and Rateau turbines, both of which are now being fitted to some extent on both warships and merchant ships. The discussion of the internal combustion engine includes some material on the use of producer gas and a considerable amount of detail on carburetion and ignition of the engine. Many engines are illustrated in section, and brief mention is made of the system described some time ago in our pages of electric transmission in connection with the Diesel oil engine.

An appendix gives questions from examination papers covering the general scope of the text, and with occasional answers where these may readily be inserted. The work is very much greater in extent than its predecessor of the second edition, and appears to form a good working text on the general subject covered.

Amérique et Japon. By John Spartali. Pages, 318. Illustrations, 75. Size, 7½ by 11¼ inches. Paris, 1908: *Le Yacht*. Price, 8.50 francs; post free, 9.25 francs.

This work, which is given a brief preface by Vice-Admiral A. Bienaimé, was called forth largely by the cruise of the American squadron around the world, and by the friction previously existing between Japan and the United States. It is divided into three parts, the first of which deals with diplomatic, political and economic questions, and with a brief history of the Spanish-American and the Russo-Japanese wars. This part comprises ten chapters and about sixty pages.

The second part describes in some detail the warships of the two powers, and it is in this part that most of the illustrations are placed. More than two hundred pages are devoted to these warships, which are taken up in order, battleships, armored cruisers and other vessels being treated in considerable detail, with illustrations, consisting of both half-tones and line drawings, the latter giving the general distribution of battery and armor.

The third section, covering about thirty-five pages, deals with the personnel of the Japanese and American armies and navies. An attempt is made to show the inferiority of the American naval crews as compared with the Japanese; while,

of course, the army of the United States, by virtue of its small size, is likewise considered far inferior to that of the rival power.

The work, which is in French, is valuable mainly by reason of the naval data and comparisons which are included.

Hendricks' Commercial Register of the United States. Size, 7½ by 10 inches. Pages, 1,240. New York, 1908: Samuel E. Hendricks Company. Price, $10.00.

This is the seventeenth annual edition of a work dating from 1891, and contains upwards of 350,000 names and addresses, classified under about 33,000 trade headings. The index to the contents covers no less than 82 pages, and the general scope of the work is such as to make it extremely valuable as a buyer's reference and for mailing purposes. It is especially devoted to the interests of the architectural, mechanical, engineering, contracting, electrical, railroad, iron, steel, hardware, mining, mill, quarrying, exporting and kindred industries. It is so arranged as to make for easy reference, is fitted for cross reference and is corrected up to date.

The Proper Distribution of Expense Burden. By A. H. Church. Size, 5⅛ by 7⅝ inches. Pages, 116. New York and London, 1908: *The Engineering Magazine.* Price, $1.00 and 4/-.

This is a contribution to the much-vexed question of correct cost accounting, and represents a series of articles on the subject, which first appeared in *The Engineering Magazine.* The correct distribution of the expense burden is a very important and difficult problem, and mistakes in this distribution have led to very frequent disaster. The analysis conducted in this volume is simple but thorough, and such as to appeal to the common sense of the reader. Broad principles are laid down by which safe and reliable figures may be obtained for machine, piece and job costs. These principles will properly distribute all expenses of manufacture, marketing and management, so that the truth may be known as to the profit or loss of any line of product, and the cause of any change in manufacturing cost may be instantly detected.

The work is divided into six chapters, as follows:

Interlocking General Charges with Piece Costs; Distributing Expense to Individual Jobs; the Scientific Machine Rate and the Supplementary Rate; Classification and Dissection of Shop Charges; Mass Production and the New Machine Rate; Apportionment of Office and Selling Expense.

Internal Combustion Engines: Their Theory, Construction and Operation. By Rolla C. Carpenter, M. M. E., LL. D., and Herman Diederichs, M. E., Professors of Experimental Engineering, Sibley College, Cornell University. Size, 6 by 9¼ inches. Pages, 597. Figures, 373. New York, 1908: D. Van Nostrand & Company. Price, $5.00 net; London: Crosby, Lockwood & Son.

This is a very comprehensive work, divided into eighteen chapters and a complete index, of which the first five chapters relate to definitions and theoretical considerations. These are followed by chapters on combustion; gas engine fuels and gas producers; the fuel mixture; history of the gas engine; modern types of engines; auxiliaries; regulation; estimation of power; testing; performance of gas engines and producers; cost of installation and of operation. The book is largely compiled from different sources, and is in the main an outgrowth of a course of lectures on the internal combustion engine delivered to students of Sibley College during the past three years.

The illustrations are scattered through the text in great profusion, and include both half-tones and line cuts, depicting exterior and sectional views of different types of engines, producers and auxiliaries and charts showing the performance of engines under various conditions, as well as indicator cards and theoretical engine cycles, etc. The use of the calculus in developing the theory in the first few chapters indicates that the book is intended for the advanced reader, but the descriptions and computations in other parts of the work are sufficiently clear and simple for anyone interested in the subject.

The last chapter shows in brief, so far as information is available, the probable capital cost of an installation of gas engines, the cost of erection, operating expenses, etc. It is shown most strongly that the question of fuel cost is not always the item of greatest importance, a point which is often lost sight of in discussions regarding the comparative merits of various prime movers. It is realized that reliable information regarding some of the features of this financial problem is very scarce, owing largely to the comparative newness, so to speak, of the gas engine problem. It is also pointed out that many so-called comparisons between various prime movers, as between steam and gas, are often based upon hypothetical estimates that fit only the particular case under discussion, and any generalization of the results obtained from such discussions often leads to serious misconception and even misrepresentation.

QUERIES AND ANSWERS.

Questions concerning marine engineering will be answered by the Editor in this column. Each communication must bear the name and address of the writer.

Q. 417.—Please illustrate Kent's method of procuring cylinder diameters for a triple-expansion engine of 8,500 indicated horsepower at 120 revolutions per minute and a boiler pressure of 250 pounds per square inch. Let the stroke be 48 inches. W. H. B.

A.—The ordinary horsepower formula is

$$I.\ H.\ P. = \frac{P\ L\ A\ N.}{33{,}000}$$

where P is the mean effective pressure referred to the low-pressure cylinder; L is the stroke in feet; A is the area of the low-pressure piston in square inches, and N is the number of strokes per minute. The mean effective pressure is given by the formula

$$p_m = p_1 \left(\frac{1 + hyp.\ log.\ r}{r} \right) - p_b.$$

where p_1 is the initial pressure of the steam in pounds absolute per square inch; p_b is the back pressure; r is the ratio of expansion.

Using the data given, and assuming that the drop in pressure between boiler and engine would balance the atmospheric pressure (14.7 pounds per square inch); assuming, further, a ratio of expansion of 12 and a back pressure of 2 pounds per square inch absolute, our formula becomes

$$p_m = 250 \left(\frac{1 + 2.4840}{12} \right) - 2 = 72.6.$$

This theoretical mean effective pressure is affected by what is known as a card factor, which takes account of the loss of pressure between cylinders, and of the rounding off of the corners of the indicator cards, due to wire drawing, compression, etc. This card factor may be assumed at 70 percent, in which case our working mean effective pressure becomes 49.4 pounds per square inch.

Reverting to the horsepower formula, and substituting for P, L and N, their values already found or assumed, we may solve for A and obtain:

$$A = \frac{8{,}500 \times 33{,}000}{49.4 \times 4 \times 240} = 5{,}851.$$

This would account for a low-pressure cylinder with a diameter of about 86¼ inches. It may be more convenient to use two low-pressure cylinders, each of an area of 2,925 square inches, or a diameter of 61 inches.

Assuming a cut-off in the high-pressure cylinder at 0.6 of the stroke, the ratio of area of the low-pressure to the high-pressure cylinder would be 12×0.6, or 7.2 to 1. The high-pressure area would be, therefore, $5,851 \div 7.2 = 813$ square inches. This gives a diameter of a trifle more than 32 inches. The area of the intermediate-pressure cylinder is usually made a mean proportional between the high pressure and the low pressure. In the present case this would be $\sqrt{5,851 \times 813} = 2,180$. This would account for an intermediate-pressure diameter of about 52 2/3 inches.

If we take our cylinders at 32, 53 and 61 inches, remembering that there are two of the latter, an engine built on these figures ought to fulfil the main features of the design.

PERSONAL

Carl C. Thomas has resigned the position of professor of marine engineering in Cornell University to accept the chairmanship of the Department of Mechanical Engineering in the University of Wisconsin. Prof. Thomas will assume the duties of the new position at the opening of the fall term, Oct. 1, of this year.

Obituary.

George W. Quintard died suddenly Sept. 5, after a long, busy and successful career. Mr. Quintard was the founder of the Quintard Iron Works, and was for many years at the head of a line of steamers running between New York and Charleston, S. C.

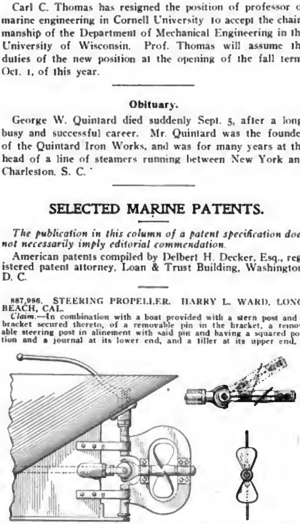
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

887,986. STEERING PROPELLER. HARRY L. WARD, LONG BEACH, CAL.

Claim.—In combination with a boat provided with a stern post and a bracket secured thereto, of a removable pin in the bracket, a removable steering post in alinement with said pin and having a squared portion and a journal at its lower end, and a tiller at its upper end, a



rudder, provided with a socket for engaging with said squared portion and journal, the central portion and edge of the rudder being recessed, curved plates on the rudder to form bearings, two straps on the stern post, each provided with a socket for engaging with said pin and journal, respectively, in the recesses of the rudder edge, a propeller shaft journaled in the bearings of the rudder, having a universal joint on its forward end, a propeller on the shaft in the central recess of the rudder, and a shaft in the vessel connected with said universal joint. One claim.

888,390. MACHINERY FOR PROPELLING VESSELS. GUSTAF DALEN, STOCKHOLM, SWEDEN.

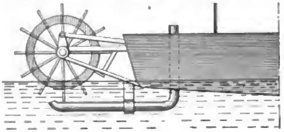
Claim 1.—Two hollow coaxial shafts, two turbine wheels, each mounted on one of said shafts and rotating them in opposite directions, a partition in the inner shaft and means for causing the working fluid to pass through a part of the inner shaft on one side of said partition to said wheels, and after leaving said wheels through said shaft on the other side of said partition to exhaust. Four claims.

888,503. STEAMSHIP. AMAND M. HUREL, NEW YORK.

Claim.—A ship, ovoidal in plan, provided with a substantially flat bottom, with propelling means at one end, and with propelling means at each side of its widest portion, each of such propelling means being movable independently of the other. One claim.

888,274. MARINE VESSEL. GEORGE F. TRISHMAN, OAKLAND, CAL.

Claim 4.—The combination with a propeller-driven marine vessel, of a tube open at each end and extending from a point adjacent to the



propeller of the vessel upward to a point above the waterline, whereby upon the operation of the propeller, air is drawn down through the tube and out of the submerged end thereof. Six claims.

888,586. BOAT-PROPELLING APPARATUS. JOHN E. CARROLL, PHILADELPHIA. ASSIGNOR TO CO. DEVELOPMENT COMPANY, PHILADELPHIA.

Claim 1.—Propelling mechanism for boats, comprising a fore-and-aft

motor-driven shaft, a propeller mounted thereon, inclined auxiliary shafts geared to said motor-driven shaft at intervals in the length thereof, and propellers on said auxiliary shafts. Four claims.

890,014. MUFFLER OR EXHAUST DEVICE FOR MARINE MOTOR. ALVAH BARBOUR, SWANS ISLAND, MAINE.

Claim 1.—A nozzle for the exhaust pipe of motor boats, having one

end adapted to connect with said exhaust pipe and the other end terminating with a conical, outwardly flaring and rearwardly discharging mouth piece, submerged below the waterline, and with its axis approximately parallel to the same. Four claims.

890,045. BOAT. CHARLES E. GRANROSE, PHILADELPHIA.

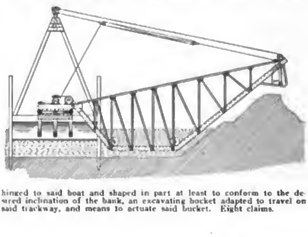
Abstract.—The object is to provide a boat with a pair of sliding boards on each side of the keel, which are so arranged that they can be moved up and down and secured in their adjusted position, so that when the boat is on its starboard tack, the port board will be lowered, which will prevent the boat from drifting laterally when on an uneven keel. Another object is, to provide a boat with curved boards which are mounted in curved wells, whereby when lowered and the boat is on an uneven keel the board will stand vertically. Two claims.

890,470. DREDGING APPARATUS. HARRISON S. TAFT, NEW YORK, AND ULDRIC THOMPSON, JR., HONOLULU.

Claim 2.—The combination in a laterally movable dredge, of a vertically adjustable dredging instrument, a diagram table, mounted on the dredge, a tracer movable over the diagram table, and connections between the tracer and the dredging instrument to change the position of the tracer in relation to the table as the dredging instrument is raised or lowered, and means mounted on the dredge to disclose the amount of lateral movement of the dredge. Thirty-two claims. See description, page 168, April, 1908.

890,909. DREDGE. CHARLES C. JACOBS, CHICAGO, ASSIGNOR TO F. C. AUSTIN DRAINAGE EXCAVATOR COMPANY, CHICAGO CORPORATION.

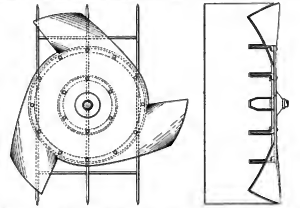
Claim 1.—In a dredge, the combination of a boat, a trackway



hinged to said boat and shaped in part at least to conform to the desired inclination of the bank, an excavating bucket adapted to travel on said trackway, and means to actuate said bucket. Eight claims.

890,973. SHIP'S PROPELLER. PADONE FILIPPI, PARIS, FRANCE.

Claim 1.—In a screw propeller, a broad, flat circular disk constituting the central portion of the propeller, and a plurality of blades extending outward from the periphery of said central disk, the forward edge of each blade being substantially on a prolonged radius of the



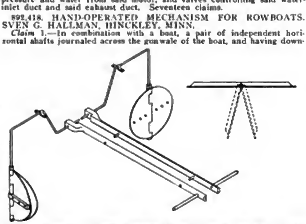
disk and the rear edge conforming approximately to a tangent of said disk, each of said blades having rearwardly turned face, whereby the water thrown outward by centrifugal force from the central portion of the propeller is received upon the face of the blades, and the formation of vortexes at the rear of the propeller is prevented. Three claims.

891,214. HYDROMOTOR. ANTON GRAF, NEWBURY, MASS., ASSIGNOR OF ONE-HALF TO JOHN JOYCE, ANDOVER, MASS.

Claim 2.—In an apparatus of the character described, a vessel, a source of steam pressure, an injector for said pressure, an injector chamber in which said injector is located, an inlet duct open to the water at the front of the vessel and communicating with said injector chamber, into which the water is drawn by said injector, a motor operated by the flow of water and the steam pressure, an exhaust duct opening into the water at the rear of the vessel for the exhaust of the steam pressure and water from said motor, and valves controlling said water-inlet duct and said exhaust duct. Seventeen claims.

892,418. HAND-OPERATED MECHANISM FOR ROWBOATS. SVEN G. HALLMAN, HINCKLEY, MINN.

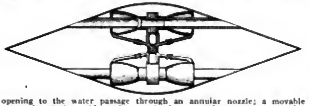
Claim 1.—In combination with a boat, a pair of independent horizontal shafts journaled across the gunwale of the boat, and having down-



wardly bent ends, a hinged propeller blade carried by the downwardly bent outer end of each shaft, a rearwardly extending handle secured upon the downwardly bent inner end of each shaft, and means for detachably connecting said handles. Two claims.

892,454. BOAT PROPULSION. ARVID T. RONSTROM, CHICAGO.

Claim 3.—In combination with the hull of a vessel having a waterway extending through said vessel longitudinally thereof, a source of fluid pressure supply, a jacket surrounding the water passage and



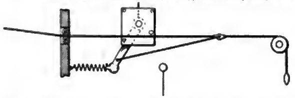
opening to the water passage through an annular nozzle; a movable means for closing said nozzle, constituting part of the waterway, and a connection between the source of fluid pressure supply and the jacket. Four claims.

893,116. SHIP. GEORGE E. WALTON, DAYTONA, FLA.

Abstract.—The object of the invention is primarily to provide a means whereby goods or merchandise, lumber for instance, may be loaded and transported without breaking bulk or rehandling when the line of transportation includes shallow as well as deep-water navigation. There is provided a vessel of proper under-water formation to adapt it for deep-water navigation, but having no deck housing, save at the bow, whereby it is adapted to receive in orderly arrangement a series of barges, such barges when in place forming the superstructure of the vessel hull. To facilitate the assembling or loading of the barges on the deep-water hull and the unloading of the same when the barges are to be used as separated units for shallow-water navigation, the deep-water hull is adapted to be submerged to a point where the barges may be floated into or out of position, the submergence or raising of the hull being effected by the filling or emptying of watertight compartments in the hull itself. Four claims.

892,572. SIGNAL DEVICE. JOSHUA W. ATLEE, RIVERTON, N. J.

Claim 2.—In a nautical signal device, an apparatus comprising means



for displaying an inclined bar of light, a sound-producing apparatus, and means for simultaneously displaying said light and operating said sound-producing apparatus. Three claims.

British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

1,217. TURBINES. J. ATKINSON, GLENBURN, STOCKPORT.

Loss of energy incurred on reducing the inlet pressure for governing purposes is reduced by arranging an adjustable injector so that the fresh steam draws in partly expanded steam from an intermediate point or from the exhaust. The invention may be applied to multi-stage velocity turbines, and in this case the injector may be combined with the nozzle delivering to the blades. It may be applied for lighter loads in cases where steam at boiler pressure is used for full loads, and a by-pass is provided for overloads. The lower stages from which steam is drawn may form separate units. Several sets of injector nozzles may be used, and they may be hand controlled. It is stated that with this device the turbine is shortened, the drum may be of one diameter throughout, less leakage occurs at the earlier rings of blades, and lower speeds are obtained.

1,397. MARINERS' COMPASSES. L. W. P. CHETWYND, F. W. CLARK, AND KELVIN & JAMES WHITE, GLASGOW.

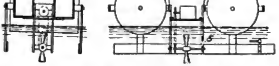
The athwartship and fore-and-aft correcting magnets are carried by vertical chains or bands running over sprocket wheels, which are rotated by means of worm gearing in order to move the magnets towards or away from the compass needles. The spindles carrying the sprockets of the fore-and-aft magnets are rotated by worms on a shaft, which may be turned by a hand wheel placed on the squared end. Similarly the sleeve carrying the sprockets of the athwartship magnets is rotated by a worm. The shafts are prevented from rotating after adjustment by means of pawl-and-ratchet mechanism. The binnacle door is provided with pins, which pass over the pawls and lock the ratchet mechanism when the door is closed.

2,807. SHIPS' BERTHS, ETC. HOSKINS & SEWELL, BORDESLEY, AND C. JOHNSON, HIGHGATE, BIRMINGHAM.

Relates to berths for ships, dormitories, railway carriages, etc., and to couches, seats, settees, etc., of the type having a main bottom frame, provided with a folding or turn-down extension, so that they can accommodate either one or two persons, the wire or other mattress fabric being in a single piece, a part of which is adapted to be folded down along with the extension. The object of the invention is to provide means for supporting and stretching the mattress fabric when the extension is turned down, such means also serving to secure and brace the extension when the latter is in the horizontal position. The main section of the bottom frame is formed of three angle-iron bars, and may be slidably supported in brackets on the bulkheads at the head and foot of the berth. The extension is formed of three bars and is connected by butt hinges to the frame. Secured to the frame by means of brackets is a rail, which lies at a sufficient distance below the mattress to prevent an occupant of the berth from resting upon it.

3,098. SHIPS AND BOATS SUPPORTED ON ROLLERS. A. FAYOL, BORDEAUX, FRANCE.

In that type of vessel in which the body is supported on smooth rotatable rollers or floats, depending longitudinal keels are fitted, and be-



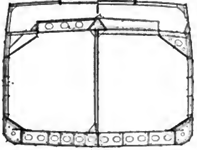
tween them the propeller works. The boat is formed by a frame and carrying shafts, on which float-cylinders freely rotate. Two parallel keels are provided, and also cross-pieces, which support a platform for the steersman. In a cage is mounted the screw propeller, which is actuated by a motor through chain or other gearing. Two cars for the reception of passengers, goods, etc., connected by stays, rest freely on the platform so as to be automatically detached if the propulsion apparatus sinks. An aërostat may replace or supplement the float-cylinders.

4,037. COALING SHIPS, ETC. A. BLIEDUNG, HAMBURG, GERMANY.

In automatic coaling apparatus for bunkers and like spaces in which a scraper conveyer having a number of closable apertures in its channel is arranged at the top of the bunker, in order to enable the storage space to be entirely filled, the chain carrying the scoops or buckets is diverted horizontally by passing it around rollers mounted on vertical axes. The channel, which is arranged under the bunker deck or on a second ceiling or deck, is of a depth equal only to that of the height of the rollers and scrapers, and thus takes up a very small space. The material is carried around from the loading shoot and is deposited into any part of the bunker through apertures, which may be closed by doors.

3,455. SCREW PROPELLERS. W. M. BERGIUS, GLASGOW.
Relates to means whereby the blades of a propeller which are adapted to feather or fold may be operated by a key from the deck or hold of the vessel. The two blades, which are secured to the boss by a bolt, can be turned into the effective radial position, or the idle position, by means of a key at the end of a shaft. This shaft is carried by a bracket, or is guided by a stuffing-box carried through the boll. The key fits over the bolt head and engages with snugs at the root of each of the blades, the shaft being first turned into suitable position, indicated by marks thereon.

3,502. SHIPS. J. A. RAMAGE, HEPBURN, DURHAM.
In cargo vessels which are fitted with permanent central longitudinal bulkheads, the hatchways are made as long as possible and of the full width of the deck, with the exception of a portion at each side sufficient to maintain the strength of the structure. Each hatchway is divided into two portions, of a width nearly equal to an ordinary hatchway, by a longitudinal girder, which may be of triangular, round, or other section. The ends of the girder are attached to the end coverings of the hatchway and to the deck. The longitudinal bulkhead may extend through the engine and boiler rooms, but always extends throughout the cargo spaces. The hold beams are dispensed with by employing strong frames, and strong gusset plates avoid the use of hold pillars.



3,502.

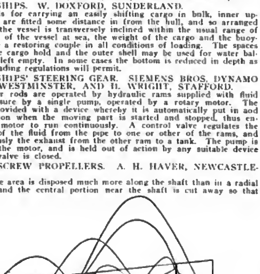
3,524.

3,524. SHIPS' LOGS. H. G. A. KLAPPROTH, HANOVER, GERMANY.
In ships' logs and speed indicators of the kind in which a plate is subjected to water pressure, an inelastic plate is pivoted to a bracket on a cylinder, and bears against a knife edge attached to the piston, from which the pressure is communicated by means of viscous oil or glycerine to a manometer, which may be empirically divided to indicate speed.

3,531. SHIPS. W. DOXFORD, SUNDERLAND.
In vessels for carrying an easily shifting cargo in bulk, inner upright walls are fitted some distance in from the hull, and so arranged that when the vessel is transversely inclined within the usual range of inclinations of the vessel at sea, the weight of the cargo and the buoyancy create a restoring couple in all conditions of loading. The spaces between the cargo hold and the outer shell may be used for water ballast, or be left empty. In some cases the bottom is reduced in depth as much as loading regulations will permit.

3,614. SHIPS' STEERING GEAR. SIEMENS BROS. DYNAMO WORKS, WESTMINSTER, AND H. WRIGHT, STAFFORD.
The tiller rods are operated by hydraulic rams supplied with fluid under pressure by a single pump, operated by a rotary motor. The pump is provided with a device whereby it is automatically put in and out of action when the moving part is started and stopped, thus enabling the motor to run continuously. A control valve regulates the admission of the fluid from the pipe to one or other of the rams, and simultaneously the exhaust from the other ram to a tank. The pump is driven by the motor, and is held out of action by any suitable device when the valve is closed.

3,930. SCREW PROPELLERS. A. H. HAVER, NEWCASTLE-ON-TYNE.
The blade area is disposed much more along the shaft than in a radial direction, and the central portion near the shaft is cut away so that

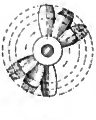


the rear part of the blade works in a separate part of the water. The blades may be affixed to a boss, tapering towards the after end and slightly tapered towards the fore end. Two sets of blades may be used, each with their centers cut away and disposed one within the other, and attached to bosses. The concentrically-placed blades may be rotated in opposite directions, or one may be stationary and the other rotating.

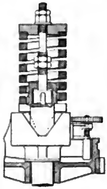
4,445 AND 4,446. TURBINES. B. LJUNGSTROM, STOCKHOLM, SWEDEN.
The vanes and guide blades of radial-flow turbines consist of perforated cylinders, the blades being supported by terminal and intermediate rings. The cylinders or blade rings are either made in one continuous piece, or the vanes and supporting rings are made separately, and are afterwards connected together. A single-stage marine turbine is formed with two expansion chambers. The stationary blade rings are secured to plates. By forming the blade rings in the above manner, the blades may be made with a very small radial extension, whereby the total diameter of the turbine is reduced.

Sets of turbine vanes are made in one piece in the form of perforated plane rings, cylinders, cones, etc. The holes are cut from the solid by a tool which is reciprocated longitudinally, and rocked so that the sides cut alternately. In modified forms of grooves, two or more tools are employed to cut the slots, acting from the same or from opposite sides. Side tools may be employed to trim the ends of the slots, the cuttings being removed by oil jets.

4,509. SCREW PROPELLERS. G. MACKANESS AND J. BARNES, SYDNEY, AUSTRALIA.
In screw propellers of the kind having manifold blades of varying diameters arranged in clusters aslant of the boss, the blades are similarly proportioned up to the limit of their diameters, each blade being similar to the one preceding it, but with a portion of the outer end removed. The ratio of the areas of the smallest and largest blade being determined, the diameter of the smallest blade is obtained, and the diameters of the intermediate blades are arranged so that the areas of the blades gradually diminish. The blades overlap slightly when viewed in end elevation, and are arranged upon the boss in the opposite direction to the pitch.



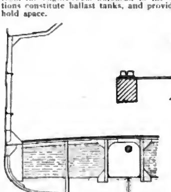
4,509.



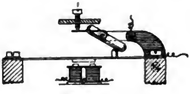
4,754.

4,754. STEERING GEAR. W. G. GIBBONS, EDINBURGH.
In a device for absorbing abnormal shocks, such as those due to a heavy sea striking the rudder, a clutch member, keyed to the steering shaft, but free to slide endways upon it, has upon one end a series of faces inclined to the axial plane. These faces engage with counterpart inclined faces on a second clutch member, which is free to rotate upon the shaft, but cannot move endways. The latter member is operatively connected to a pinion which is loose on the shaft, and is driven from the steering gear through a friction clutch. The inclined faces are in series of opposite hand, so that control of movement in either direction is effected.

5,660. SHIPS' PROPELLER SHAFT, TUNNELS, TANKS. J. T. DUNCAN, CARDIFF.
The plating of the roof of the propeller-shaft tunnel is made continuous from side to side of the ship for the entire length of the ship from the engine-room bulkhead to the stern bulkhead. The wing portions constitute ballast tanks, and provide an uninterrupted floor to the hold space.



5,660.



6,253.

6,253. SUBMARINE SOUND SIGNALING. J. GARDNER, KNOTT END, LANCASHIRE.
Relates mainly to the disposition of the microphonic contacts on the diaphragm or blade of the receiving instrument for submarine sound signaling. The pulsatory currents, generated at the telephonic transmitter which receives the sounds, and flowing in the coils of the magnet, if of the proper frequency, cause the armature and tuned strip to vibrate. When the strip is at rest, a constant current flows through the electrodes of the microphone, and holds a signal-operating electromagnetic device, which is in series with the electrodes, in position; but on the arrival of the appropriate sound at the receiving transmitter, the electrode is vibrated and an increase in resistance at the point of contact of the electrodes takes place, and the resulting diminution of the current causes the signal-operating electromagnetic device to be actuated. According to the present invention there is very little vibration of the weighted strip near its fixed ends, and the change from the vibrating part to the non-vibrating part takes place with comparative suddenness.

International Marine Engineering

NOVEMBER, 1908.

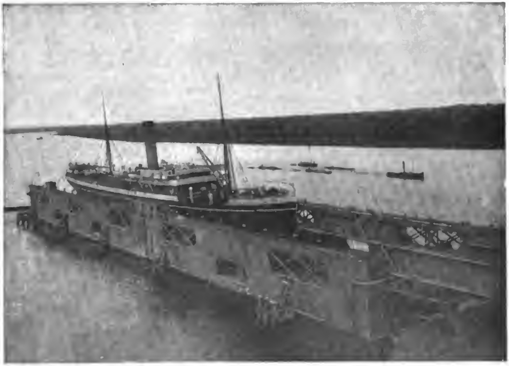
THE SHIPBUILDING AND ENGINEERING COMPANY OF BURMEISTER & WAIN.

BY AXEL HOLM.

This company, which employs 3,000 workmen, made its first appearance in 1846. The firm then was called the Baumgarten & Burmeister Engineering Company, and employed only thirty men in a little workshop in the middle of the town (Copenhagen, Denmark). In 1851 the firm leased a small shipbuilding yard near the present company's engineering department, in the Copenhagen inner harbor, on the Christianshavn side, where they launched their first wooden steamship in 1854, the paddle steamer *Hermod*, and from this unpretentious beginning grew gradually the present large company. In 1872 the present yard on the island of Rephalen in the outer harbor was established, and at the same time the whole work was transferred to a joint stock company, under the name of the Burmeister & Wain Shipbuilding & Engineering Company. The first ships launched here were ships Nos. 83 and 84, the steamships *Christiania* and *Christian IX.*, on the 12th of April, 1874.

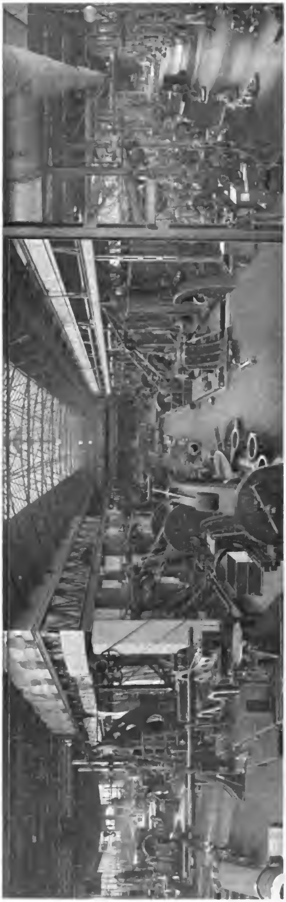
Now the company occupies in the inner harbor an area of 9 acres, where only the engineering departments are situated, and on the island Rephalen 18 acres of land, a partially filled up area, and 6½ acres water area belongs to the shipbuilding department.

As may be seen from the accompanying plan, the yard possesses four large building berths, three slips, a graving dock and a large floating dock. The building berths are 420 feet, 350 feet, 300 feet and 250 feet in length, with all necessary derrick cranes and electric winches for handling the materials; the slips are two, 275 feet in length and one 310 feet, operated by hydraulic power. The graving dock, which is capable of holding ships of 10,000 tons, is 470 feet in length, 64 feet 9 inches in breadth and 23 feet depth at sill, and is divided into two smaller compartments by steel caissons. The dock was built in 1894, of granite concrete (in this year a great fire burst out on the island and partially damaged the gates under construction). Of the four steam centrifugal pumps for this dock are three with 20-inch suction and one with 8-inch suction, the common discharge channel being 3 feet 6 inches by 2 feet 3 inches. On the dock quays are traveling cranes of 15 tons capacity.



THE FLOATING DOCK IN THE OUTER HARBOR AT COPENHAGEN.

In 1906 a great floating dock was purchased in Antwerp



THREE VIEWS IN THE ENGINEERING SHOP OF BURMEISTER & WAIN, SHIPBUILDERS, COPENHAGEN, DENMARK.

ON THE HAULING-OUT SLIPS.

and towed to Copenhagen. This dock measures 493 feet in length, 98 feet in breadth outside, 70 feet inside and 23 feet depth over keel blocks. The dock's lifting capacity is 11,500 tons, and it is divided into two parts, 3/7 and 4/7, for two smaller vessels. The machinery is all newly installed and works by electricity. There are seven centrifugal pumps, operated by electric motors, at 220 volts and 440 amperes, and six winches for hauling and hoisting purposes. The lighting is also electric, and means are provided for the use of electric drills, as also for pneumatic tools; all power is developed from the yard's power station on shore. The passage from dock to yard is provided for by means of a 17-foot wide floating bridge.

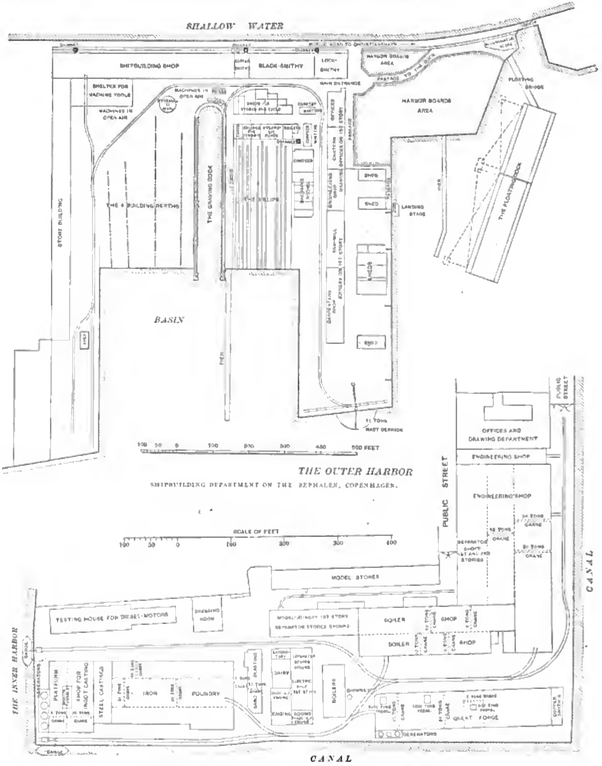
In respect to tools, machines and cranes the yard's whole outfit is up to date. There are three steam cranes of 5 tons lifting power, traveling on a wide gear system of rails; one mast derrick, 100 feet in height, with a lifting capacity of 10 tons, and several small derricks and overhead cranes for hand and electric power. The power plant consists of two steam dynamos of 400 horsepower and one of 300 horsepower, as also a great accumulator battery and an air compressor of 150 horsepower. There are three Babcock & Wilcox water-tube boilers of 1,850 square feet heating surface and one of 90 square feet, together with a marine boiler of 90 square feet, all working with a pressure of 150 pounds per square inch. The machine tools are all driven by separate motors; 220 volts are used for power and 110 volts for lighting.

Several punching and shearing machines for plates and profiles, hydraulic manhole punchers, pressers and riveters, a hydraulic cold flanging machine, plate bending rolls and manglers, edge planing machines, a plate joggling machine and a corner planer for joggled plates, beam benders, beveling machines, saws, drills and countersinkers, etc., all of English make, are distributed in the shipbuilding shop at the east side

A CORNER OF THE SHIPBUILDING SHOP.

of the yard and in open air. In the shop also are installed the great plate and angle oven, the bending slabs and the scrive boards. In connection with the construction depart-

find another large building sheltering the joiner shops, the carpenters' shop, a small engine repairing shop, the canteen and the drawing offices, etc.



SHIPBUILDING DEPARTMENT ON THE REFSHALEN, COPENHAGEN.

ENGINEERING DEPARTMENT OF BURMEISTER & WAIN, CHRISTIANSHAVN, COPENHAGEN.

ment are built small shops for coppersmiths, blacksmiths and locksmiths, these departments having their main shops at the engineering department on Christianshavn. At the yard's northern side is the large store building, and at the south we

The engineering department on Christianshavn is also up to date, owing to the several great newly-erected shops, large purchases of new pieces of land, newly-provided modern machine tools, enlargements, etc. The power distribution here

GENERAL VIEW OF THE SHIPYARD OF BURMEISTER & WAIN, COPENHAGEN.

is also electrical throughout, direct-current motors being used.

In the power station are installed two vertical triple expansion engines of about 400 horsepower, and one large horizontal compound tandem engine of about 2,000 horsepower (the greatest of this type in Scandinavia and from the company's own works), all coupled to direct-current dynamos, giving 220 volts for power and 110 volts for lighting. The boilers are: one Babcock & Wilcox of 435 square feet heating surface; two Lancashire boilers of 285 square feet each, and three other Babcock & Wilcox, each of 722 square feet heating surface; all with mechanical stokers and superheaters. The working pressure is 150 pounds. There is also installed an air compressor of about 150 horsepower. On rails running between all departments travel two steam "jumboes" of 3 and 7 tons capacity, and one locomotive for transport of boilers, scrap and heavy work.

The new and fully modern engine shop is divided into three bays; the main bay is 350 feet in length, 67 feet 6 inches in breadth and 42 feet 6 inches in height. One side bay is 260 feet in length, 51 feet in breadth and 40 feet in height; while the other side bay is 260 feet by 56 feet and 23 feet in height, and over this bay is installed the large cream separator works in two stories, each about 16 feet in height. In the engine shop are three electric overhead cranes of 30, 20 and 12 tons lifting power, with auxiliary lifts. The machine tools are all new and up to date, with separate electric motors and of English, German and American manufacture. Among others is installed a large turning lathe for propeller shafts, driven by a 7-horsepower motor—the largest lathe in Scandinavia. Another lathe is capable of turning shafts 65 feet in length, etc., all working with high-speed steels.

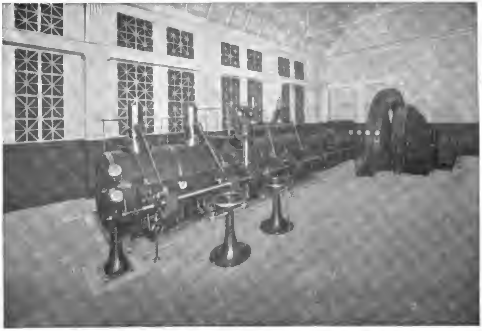
The shops are wooden paved throughout, and dressing rooms and lavatories are provided for the laborers' use. The heating is through hot air (the Buffalo system), 4,600,000 cubic feet of hot air being delivered per hour; the exhaust steam from presses and steam hammers is used for this purpose.

The boiler works occupy two shops, 295 feet in length, 49 feet 3 inches in breadth and 42 feet 9 inches in height, and here are arranged two overhead electric cranes of 10 and 40 tons lifting power, also with auxiliary lifts, besides two smaller ones for 3 and 5 tons. The shops are fitted with hydraulic riveting engines in pits, vertical plate rollers, cold flanging machines and several boring and planing machines, etc. Also, there is installed a large plate oven, heated by gas. The work is capable of delivering all kinds of boilers up to the largest sizes in use.

The great forge shop is 390 feet by 51 feet by 72 feet in height. The two overhead cranes here are of 35 and 20 tons capacity, the 35-ton crane having an auxiliary lift of 5 tons capacity, and several other small cranes are installed. There are seven steam hammers of different sizes and makes, with the accompanying furnaces. Three gas generators supply gas to six heating furnaces for large forge pieces, which are worked out by means of two hydraulic presses of 1,200 and 2,000 tons pressure, respectively. There is in addition another hydraulic press of 800 tons pressure, with separate coke furnaces, and a 6-ton crane. The presses are all of German make, and the 2,000-ton press has just been installed. The manufacture of shafts and heavy forge pieces has, through these excellent tools, increased to about 3,000 tons a year in 1906, against 1,000 in 1899. A great deal of the output is exported to Scotland, England, Norway, Finland and North Germany. The ingots for these forgings were formerly taken from Germany, but now a large Martin steel works is under erection.

The great foundry is an almost new building, erected in 1900, of steel framework, with brick filling (the engine shop also is partially steel and brick-built). The building is 280 feet in length, with three bays, the middle bay being 52 feet

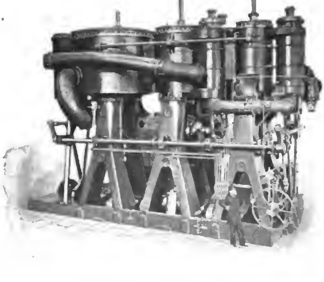
THE ENGINEERING DEPARTMENT AT CHRISTIANSHAVN, IN THE INNER HARBOR.



THE 2,000-HORSEPOWER ENGINE AND DYNAMO IN THE ENGINE ROOM.

6 inches broad and 46 feet high, and the two side bays 32 feet 9 inches broad by 26 feet 3 inches high. Here travel three overhead cranes of 20, 20 and 10 tons lifting capacity. Three cupola furnaces, two drying hearths and several casting pits are arranged for, and the foundry can deliver pieces up to 25 tons. A metal foundry is also located here. The sand blasting for cleaning takes place in a separate house close to the foundry.

In connection with this iron foundry is the new Siemens-Martin plant under erection. It is planned for a yearly output of 10,000 tons. and the shop, built of steel framework, has a ground area of 148 feet by 72 feet 6 inches, and is 51 feet high. The shop will be equipped with one Martin furnace of Swedish pattern for charges of 20 tons, with four generators producing the necessary gases. For handling the raw material, the scrap and pig iron, a 6-ton electric molding crane and



MAIN ENGINE FOR IMPERIAL YACHT STANDART.

electric elevators are to be installed, together with the necessary cranes for the coal and scrap from barges. In the shop will also be arranged an overhead electric crane of 35 tons lifting power, with an auxiliary lift. The work is intended only to deliver ingots for forgings and cast steel pieces.

In the Christianshavn plant are a testing house for Diesel motors, a model joinery with roomy storehouses, stores for cream separators, a laboratory, a testing dairy, coppersmithy and painters' shop; and close to the main entrance are situated the large and well-lighted drawing offices (for about thirty men) and the several managing offices for both yard and engine department.

Among the several prominent works done by the firm may be mentioned the Russian imperial steam yacht *Standart*, the Russian cruiser *Bojarin* (lost in the Russian-Japanese war), together with several large cargo and passenger steamers, and the whole engineering outfit for the large pumping stations for the Copenhagen drinking water supply, and for the electric power and light centrals of Copenhagen, Stockholm, St. Petersburg and Baku, etc.

THE SHEARING STRENGTH OF RIVETED SEAMS IN SHELL PLATING.

BY R. E. ANDERSON.

In the design of vessels of certain types it frequently becomes desirable to investigate the longitudinal shearing forces which will obtain in the seams of the shell plating, in order to be certain that sufficient strength is provided in the riveted connection. The exact nature of these longitudinal or horizontal shearing forces is not always clearly appreciated. The consideration of one or two simple examples should, however, make the matter clear.

If we take a book having limp covers, or a pile of paper or cards, and bend it, it offers very little resistance, and we notice that the leaves or the cards slide slightly upon each other. This is because each leaf retains its original length; there is nothing to make the leaves on one side compress and those on the other side stretch, as they would if they were well glued together, and so each leaf bends separately.

Similarly, if we take four or five boards, and, laying them

one on top of another, use them thus as a beam to support a load, they will bend considerably if the load is a heavy one. If we have made some pencil marks on the edges of the boards we will find that there has been a slight sliding of the boards upon each other, and that this sliding is greatest near the ends. We can prevent the sliding by spiking the boards together. If we put in only one or two spikes we shall not prevent the sliding, because the wood around each spike will crush, or perhaps, if we have used wooden dowels instead of spikes, the dowels will break; but if we put in enough spikes or dowels we can prevent the sliding altogether, and the beam will not bend under the load nearly as much as it did before the spikes were put in. The tendency for the boards to slide upon each other will be just as great as before,

Now, all the fibers above BB' are in tension, but since the bending moment at B is greater than at B', the tension on any given fiber is greater at B than at B'. Thus, on the plane AB there is a total pull which is greater than the pull on $A'B'$, and were there nothing to resist it the whole block $ABB'A'$ would begin to move to the left. It would not be prevented from moving by the portion of the beam to the left, nor by the portion to the right, for a precisely similar tendency exists for these portions of the beam to move also in the same direction. Motion is, however, prevented by the fact that the portion below BB' has much less tendency to move, or rather, considering the entire portion below BB' to the lower edge of the beam, has an exactly equal tendency to move in the opposite direction, and the ability of these por-

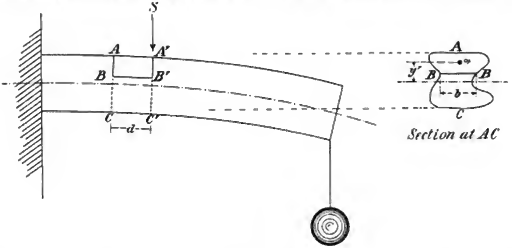


FIG. 1.

but it will be taken up by the spikes. This tendency to slide is the longitudinal shearing force, and it develops a shearing stress in the spikes. If the beam had been a solid piece of timber instead of being made up of a number of layers, the longitudinal shear would still have existed, but it would have been resisted by the shearing strength of the timber itself instead of by the spikes.

It will be seen that the capability of the spikes to resist the shearing force determines whether the beam will act as a unit, or only as several thin boards. Before we spiked the boards together the beam could bend by bending each board independently; after we put the spikes in the beam could bend only by stretching the boards on one side and compressing those on the other. It is evident, then, that if a complicated riveted structure is to act as a unit, and is to obey the laws upon which the ordinary formulæ for the strength of a girder are based, and which assume that the stresses and the consequent stretch and compression of the material are in direct proportion to the distance from the neutral axis, its various parts must be so connected together that their tendency to slide upon each other is efficiently resisted. In order to provide for resisting the tendency to slide, we must know how great that tendency is; in other words, we must know the value of the longitudinal shearing force.

DERIVATION OF FORMULA.

Consider, for example, the upper side of a beam which is so loaded as to put the lower side into compression and the upper side into tension; that is, it is fixed at one end and loaded at the other (Fig. 1). Assume that we wish to investigate the forces acting on the plane BB', which is somewhat above the neutral axis; and in order that our problem may not be unduly complicated we will let BB' be relatively very short.

tions to resist their tendency to slide upon each other constitutes the longitudinal shearing strength of that part of the beam on the plane BB'.

It is necessary here to assume acquaintance with the elementary formula for the stress in a beam:

$$p = \frac{M y}{I}$$

where p is the intensity of the stress in any fiber distant y from the neutral axis. M is the bending moment on the beam at the point in question, and I is the moment of inertia of the cross section of the beam.

Now to determine the *whole amount of pull* on the portion AB of the beam, we must multiply together the area of that portion by the average intensity of the pull. This average intensity will be the same as the intensity of the pull on that fiber which is at the center of gravity of the portion we are considering. We must therefore multiply together the number of square inches in the portion ABB and the pull per square inch at the center of gravity of ABB.

Now let y' be the distance from the center of gravity of ABB to the neutral axis, and let a be the area of ABB. Then the average pull per square inch is

$$p = \frac{M y'}{I},$$

and the whole pull on ABB is

$$P = \frac{M y' a}{I}.$$

Likewise, the whole pull on $A'B'B'$ is

$$P' = \frac{M' y' a}{I}.$$

The difference between these pulls, or the whole shearing force on the plane BB' (which force we will call F), is

$$F = \frac{M\,y'\,a}{I} - \frac{M'\,y'\,a}{I},$$

or

$$F = \frac{y'\,a}{I}\,(M - M') \ldots\ldots\ldots\ldots\ldots (1)$$

It is now necessary to find the value of $M - M'$. Consider again Fig. 1. We can cut the beam through at $A'C'$, and leave the conditions at AC unaffected, provided we replace all the internal forces acting on $A'C'$ by external forces of like nature and value. We have on $A'C'$ a direct pull above the neutral axis, varying in intensity from nothing at the neutral axis to a maximum at A', and this we can replace by an external force or a series of forces acting in the direction of the beam. In like manner we can replace the compressive forces below the axis by external forces also acting in the direction of the beam. There remains, however, the vertical shearing force tending to make the portion to the right of $A'C'$ slide downwards. This may be replaced by an equal external force, which we will call S, the vertical shear on the section. These three forces, or series of forces, completely replace all those acting on the plane $A'C'$, and the conditions at AC will therefore be unchanged.

Now, the bending moment on AC must be the sum of the moments of these forces. The moments of the pulling forces above the axis, and of the compressive forces below the axis, must be the same at AC as at $A'C'$, since these forces act in the direction of the beam, and their sum is M', since it was M' that they replaced. If d be the distance between AC and $A'C'$, the moment of S is Sd.

We have, therefore, for the bending moment at AC,

$$M = M' + Sd,$$

whence

$$M - M' = Sd \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

This is true so long as d is a comparatively short distance, or rather so long as d is not too great for the force S to be regarded as practically constant. Putting this into equation (1) we have

$$F = \frac{y'\,a}{I}\,Sd \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

This gives the whole shearing force on the plane BB'. To get the stress per square inch we must divide by the area affected, which is $b \times d$, where b is the breadth of the beam at the point in question.

We observe also that the quantity $y'\,a$ is the statical moment of that portion of the cross section of the beam which is outside of the plane of shear BB'. Representing $y'\,a$ then by m, and dividing by $b \times d$, we have finally for shearing stress per square inch on any longitudinal plane at a given distrance from the neutral axis:

$$f = \frac{mS}{Ib} \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

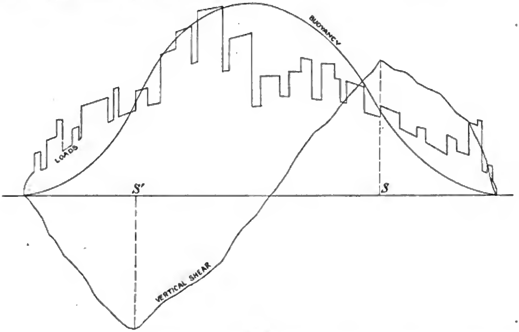


FIG. 2.

which is the general equation for longitudinal shear in a beam, and may be stated thus:

To find the intensity of the longitudinal shear at any point in the cross section of a beam, multiply the total cross shear on the section by the statical moment of that portion of the section which lies outside the point in question, taking this moment about the neutral axis, and divide by the product of the breadth of the beam at the point in question and the moment of inertia of the whole section.

It will be noticed at once that the value of m is greatest for the neutral axis itself, and that, consequently, for any beam the longitudinal shear is greatest at the neutral axis, the exception being a beam which is locally very thin at some point not very far from the neutral axis, in which case the maximum shear may come at this point.

In the derivation of these equations the use of the calculus has been purposely avoided. Those who prefer the more rigid mathematical treatment are referred to any of the standard works on applied mechanics.

APPLICATION TO SHELL RIVETS.

In the case of a ship, we have a beam very similar to the one used as an illustration in the beginning of this paper. We considered there a beam formed of several layers of wood, held together and made to work as one by spikes; and we discovered that there was a shearing stress set up in the

spikes. We may consider the ship as a beam wherein each strake of shell plating corresponds to one of the layers of wood in our illustration, and it will be seen at once that the rivets in the seams perform the same function as the spikes.

Now the shearing force as determined by equation (4) exists throughout the cross section of the ship, but is resisted by less material at the seams than elsewhere, and hence it is necessary to investigate only the conditions in the seam and the stress to which the seam rivets are subjected.

In equation (4), if all the values are so taken as to give the result in terms of shearing stress per square inch, we can replace the term b by the area of material per inch of length which is subjected to the shear. Thus if

$$a = \text{area of one rivet,}$$

and

$$p = \text{pitch in inches,}$$

the area per inch of length is $\frac{a}{p}$ for each row of rivets, and for a single riveted seam, observing that the resistance is divided between the two sides of the ship, we have

$$f = \frac{m\,S\,p}{2\,I\,a} \qquad (5)$$

for a double riveted seam,

$$f = \frac{m\,S\,p}{4\,I\,a} \qquad (6)$$

for a treble riveted seam,

$$f = \frac{m\,S\,p}{6\,I\,a} \qquad (7)$$

and so on.

Two points are to be observed: First, these formulæ are based entirely on the rivets, assuming that they are the weakest part of the joint, and if the plate efficiency is less than the rivet efficiency (that is, if the area of the plate remaining between the holes for the rivets in the outer rows is less than the area of all the rivets, which is very likely to be the case for a treble riveted seam), the critical stress will be that in the plate, not that in the rivets, and its value can be obtained from the formula by increasing f in the ratio of the plate area to the rivet area, or by substituting

$$\left(t - \frac{d}{p}\right) \text{ for } \frac{a}{p}$$

in the formula (5), where t is the thickness of the plating in inches and d is the diameter of the rivet. Secondly, no account is taken of any longitudinal bulkheads which may bear a portion of the shear; their effect is better obtained by carefully studying the particular conditions, and modifying the calculations accordingly, than by any attempt to include such complications in the general formula, especially as the presence of such bulkheads generally removes all doubt as to the strength of the shell riveting, and renders any calculation unnecessary.

In applying the formula, it must be observed that the moment of inertia and the statical moment are not those for the midship section used in the ordinary strength calculation, but must be found for the section of the vessel which comes at the point of maximum shear. There are always two such points, and they come not far from the quarter length of the vessel from each end. A glance at Fig. 2 will show this. In this figure are shown the weight and buoyancy curves for a vessel, and the corresponding shearing force curve, the ordinates of which represent the difference between the weight and buoyancy from point to point. The maxima occur at S and S', and these are the values to be used in the equation, the moment of inertia and the statical moment of the vessel's cross section being calculated for these points.

As the amount of the vertical shearing forces have generally been computed incidentally to the standard strength calculation, the curve of shearing forces is available. The additional labor necessary to find the longitudinal shear consists, therefore, in making the inertia calculation for the section where the maximum shear occurs. In many cases, however, a fairly close approximation can be had without calculating this section, by taking advantage of the inertia calculation for the midship section, which has presumably been made for the standard strength calculation. Provided the general structure of the vessel does not change materially in type between the midship section and the point of maximum shear, the ratio of the statical moment to the moment of inertia will remain practically constant. The value of $\frac{m}{I}$ can therefore be obtained from the midship section, and used in equations (5), (6) and (7) for an approximate result. Of course, if this approximation shows the riveting to be in a critical condition the exact method should be resorted to.

As regards the statical moment to be used, it will be remembered that in making an inertia calculation it is necessary to calculate the statical moment of all the items above an assumed axis, and also the statical moment of all the items below that axis, and to find the location of the true axis by making these two moments equal, in order that the axis may pass through the center of gravity. It is one of these two equal moments which is to be used in our formula. If the seam we are investigating does not come right at the neutral axis, the moment of the intervening material is, of course, to be subtracted.

Some caution is necessary with reference to the units used. The equations have been based upon the assumption that all the measurements have been in inches. In the inertia calculation, however, it is customary to measure the areas in square inches and the lever arms in feet, so that the statical moment is obtained in terms of square inches times feet, and the moment of inertia in terms of square inches times feet squared. If this practice is followed the values of the statical moment and the moment of inertia must be multiplied by 12 and 144, respectively, in order that they may be in terms of inches only. The same thing may obviously be accomplished by dividing the value of $\frac{m}{I}$ by 12.

If the calculations indicate that the riveting is deficient, the question arises as to how the weakness may be remedied. The first thought is to add another row of rivets. It was mentioned above, however, that the plate may in some cases be weaker than the rivets, in which case merely to add to the number of rivets would not increase the strength of the joint. Or, the relative strength of the punched-out plate and the rivets may be such that, while the plate is slightly stronger than the rivets, the addition of another row of rivets would make the rivets much stronger than the plate, and the advantage of the added rivets would be largely, if not altogether, lost. In either case, it is necessary to find some other means of strengthening the joint.

Since watertight spacing of rivets must be maintained along the calking edge, there are two methods open to use. We can retain the lapped joint and fit a supplementary strap on the inside, or we can make the joint flush, with a regular seam strap on the inside. Either of these methods allows us to space the outer rivets in the strap widely, and so maintain the plate efficiency. If the flush seam is adopted, care must be taken to make the seam strap thick enough, since its strength will be that of the net area through the watertight

spaced rivets. Of course, neither expedient has to be employed throughout the entire length of the vessel, but only for such a distance as the magnitude of the shearing forces renders necessary.

THE VESTIBULE SOCIAL HALL ON THE CORCOVADO.

New German-Built Steamers for Brazil.

BY MAX A. R. BRUNNER.

About a year ago the Hamburg-American Co. considerably improved its service to La Plata countries by installing the luxurious and fast boats *König Friedrich August* and *König Wilhelm II*. A further development is taking place this year, with two new ships, the *Corcovado* and *Ypiranga*, of which the former was ready for service in March, the other in July. These vessels surpass all others engaged in the Brazilian service, both as regards size and luxurious equipment of the passenger rooms. Each has a capacity of 7,800 gross register tons.

In both ships the experiences made on tropical cruises have been carefully utilized, so that they are specially adapted to the requirements in those zones. The cabins are very roomy and airy, are located in the high deck structures, well ventilated and furnished. All have their windows outside, there being no inner cabins on these boats. A novelty for the Brazil service is the large number of one-bed rooms. There are also cabins-de-luxe, consisting of parlor, sleeping room and bath. Each vessel has accommodations for about one hundred first class passengers. All staterooms are equipped with electric light, and many with telephones. White has been chosen as color for walls, ceilings, etc. This applies also to the general rooms.

The dining saloon is specially worth mentioning. It contains tables for five to eight persons, which shows again the tendency of German companies to abolish the table d'hôte system. Excellent taste is shown in the arranging of colors of the furniture, carpets, curtains, etc., matching the bright gold and white of the ceiling and walls.

Each vessel possesses a large hall, located on the promenade-deck, a room with eight corners and four niches. It is decorated in Roman style. Abundance of light is furnished by six broad windows and the skylight; the latter contains colored glass panes which represent four beautiful Brazilian landscapes. In the center are writing tables, a large piano, comfortable lounges and sofas, etc. One of the niches contains a fire-place; the others are furnished with book stands, club chairs, rockers, etc. By this arrangement the hall is neither exclusively a ladies' room nor only for gentlemen, but a social hall for both. It will be much occupied when rain or unusual heat makes the decks unpleasant.

A smoking saloon is also provided, furnished and decorated in Flemish style. It has dark oak squares in the walls and floor, and is decorated with Delft paintings representing various sports. Antique leather chairs and sofas constitute its furniture. Each boat contains a children's room, equipped with pretty oak furniture; this serves as dining and playroom for the little ones.

THE CORCOVADO APPROACHING COMPLETION.

Stairways, corridors, decks, etc., are very roomy and airy to render the stay on board pleasant, even in those very hot zones. The *Corcovado* has in the stairway vestibule a large painting representing the high mountain Corcovado, near Rio de Janeiro.

Each vessel has accommodation for about 1,200 steerage passengers.

diagonal *MN*. Their distances from the middle of the rectangle, being in inverse proportion to the areas of the part in question, can also be readily determined.

Referring again to Fig. 2, the centers of the immersed parts of the rectangle at the different inclinations may now be found by simple methods which need not be here elaborated. The line XX_1X_4 in Fig. 3 is the locus of these.

THE FIRST CABIN SMOKING ROOM ON THE BRAZILIAN STEAMSHIP CORCOVADO.

NOTES ON NAVAL SCIENCE TOPICS.

BY ARTHUR R. LIDDELL.

STABILITY.

Much has been written within the last thirty years about stability, and many methods have been put forward for determining the righting moments of vessels inclined to different angles under given conditions of wind, weather, and loading. There is a general tendency, however, to avoid the subject, first, because the methods for dealing with it entail time and labor, and, secondly, because clear ideas as to the degree of righting tendency necessary for a vessel under the various conditions of her service have yet to be formed and embodied in rules for general guidance. As a rapid method of approximately determining the stability of vessels of full form, the following may be proposed:

The conditions in such a vessel are approximately the same as those of an equivalent rectangular block, such as that shown in section in Fig. 1. The curve of levers of the latter may be quickly obtained as follows:

Assume a loadline *AB* (Fig 2) and incline the rectangle until the surface of the water successively assumes the positions *CD, EF, GH*, and *IK* with reference to it. With the exceptions of those at *EF*, the points in which these position lines cut the outlines of the figure may at once be determined. In regard to *EF*, if the rectangle *MB* be *a* times *MN*, and

$$\frac{ME}{MO} = \frac{ME}{MD}, \text{ then } \frac{ME}{MG} = \sqrt{2a}$$

and the centers of the figures *MEF* and *EGNDF* lie on the

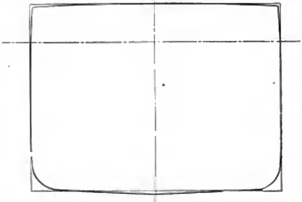


FIG. 1.

We may now assume the side *ND* to be produced upwards, so that the line *GH* would, at the same inclination and for the same immersed area, take up the position G_2H_2. For this condition of things the new center is at Y_2, and a further center Y_4 may be obtained, say for a triangle *PQN* of the same area, but of twice the height of H_2G_2N. A new locus, diverging from the old one, may now be drawn through the points Y, Y_2, Y_4, which would satisfy the condition of the vessel's having erections of unbounded height extending all fore and aft. As a matter of fact the erections will be of a certain limited height, and will extend over a portion only of the length.

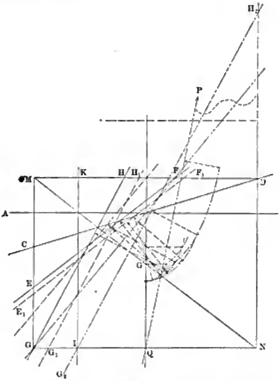


FIG. 2.

A locus XZZ_4, in a position intermediate between those of XX_1X_4 and XYY_4, may now be sketched in, as shown by the dotted line in the figure, and, if necessary, checked and corrected in accordance with the real heights and longitudinal distribution of the erections, whereby the latter may be taken as having the breadth of the rectangular section and their own actual longitudinal positions. This correction, though not a very difficult one, forms the most troublesome part of the rectangular method.

Fig. 4 shows a curve of levers measured from Fig. 3 on the assumption that the center of gravity of the vessel coincides with her center of buoyancy when she is upright.

The probable position of the actual center of gravity may, in the meantime, have been assumed or approximately determined, say by the method sketched in the August (1907) number of this journal. Assume that it takes the position G, in Fig. 3. Since the heights of the centers of gravity above, or their depths below, the metacenter become direct leverages at an inclination of 90 degrees, the height CG may be set down from the 90 degrees spot of the lever curve in Fig. 5.

Now the curve of levers (or alteration of levers), due to an alteration in the height of the center of gravity of a vessel, is simply a curve of sines. The lever for an inclination of 30 degrees is, for instance, equal to CG sin 30 degrees, or $CG \times \frac{1}{2}$, and a distance of $\frac{1}{2}$ CG may then at once be set down from the original lever curve at the station for 30 degrees. A curve of sines may, in fact, be quickly set off from the original curve, and the new line will be the curve of levers corresponding with the G position of the center of gravity. In similar manner, additional lever curves may readily be drawn corresponding with other positions of the center of gravity, and the designer will be in a position to judge fairly enough as to the stability characteristics pertaining to his proposed model.

For sketching out curves for different positions of the center of gravity, it is convenient to remember the following approximate figures:

Sin $7\frac{1}{2}°$	$= 0.13$	Sin $45°$	$= 0.71$
" $11\frac{1}{2}°$	$= 0.2$	" $64\frac{1}{4}°$	$= 0.9$
" $30°$	$= 0.5$	" $90°$	$= 1.0$

The characteristics of the lever curves of vessels of finer form will be less like those of their equivalent rectangles, but a little experience with the method, on the part of the designer, will enable him to sketch in the necessary corrections. An example of this, for a fine-lined sailing vessel, is given in Fig. 5, which shows lever curves for GM heights of 0 and 3 feet, respectively. The displacement of the vessel was 3,100

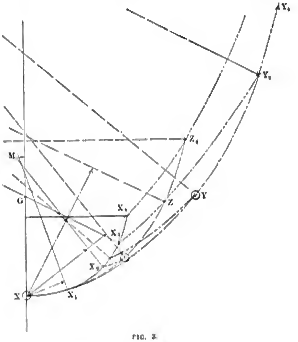


FIG. 3.

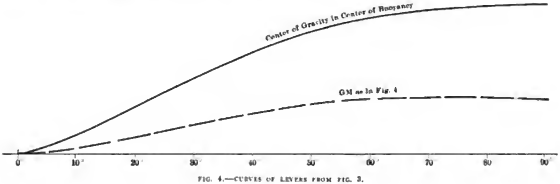


FIG. 4.—CURVES OF LEVERS FROM FIG. 3.

tons, and her block coefficient 0.66. The full lines are obtained by the ordinary methods, and the dotted ones by the rectangular one above described. The principal differences are that due to the tumble home of the vessel's side, which acts in lowering the curve between the inclinations of 20 degrees and 65 degrees, and that caused by the distribution towards the deck of the displacement of the fine ends.

For many purposes the approximate curves would suffice without correction, even for this rather extreme case, while for vessels of box-like form, with nearly vertical sides, the differences are very much smaller. If, for instance, the middle body of the above vessel were increased in length until her block coefficient became about 0.8, the differences between the lever curves as given by the two methods might be one-third of those shown in the figure.

The question as to how much stability a vessel ought to have must be answered according to her class and service. As mentioned in the August number, the *GM* height required for a sailing vessel has been put at from 3 feet to 3 feet 6 inches for all classes of sailing vessels. Provided the proportion of breadth to draft, or of area of load waterline to displacement, height required, and this, multiplied by the sine of any angle between 0 degrees and 90 degrees, will give an offset for the new curve. The latter curve must be set off from the old one, and, of course, cuts the base-line at 60 degrees, as required.

For a cargo steamer the problem is a different one. Approximately constant inclining forces, such as that of the wind on the sails, are here of small account. The all-important conditions are that the vessel should stand upright in smooth water under all conditions of loading, and that she be safe against being rolled over in a seaway.

As regards the first of these, the vessel should, under ordinary conditions, have positive levers up to inclinations of about 60 degrees. In the most unfavorable state of her bunkers, and with the largest amount of free water in bilges and double bottom that is likely to get there on service, she must have a *GM* height of at least 6 inches. In vessels in which breadth is large in proportion to depth, a range of positive stability up to 60 degrees may not be attainable without the accompaniment of excessive stability at the small angles. In such cases the range may have to be reduced, but the special circumstances should then be duly weighed.

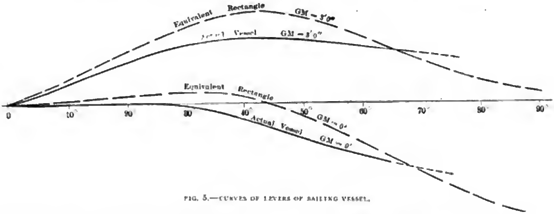


FIG. 5.—CURVES OF LEVERS OF SAILING VESSEL.

lies within ordinary limits, this height is approximately correct. In the case of vessels that are broad in relation to their depth, it is necessary to increase the *GM* height, because the righting levers, though relatively large at the smaller angles of heel, are relatively small at the larger ones. This state of things may become dangerous in two ways: A lull in the wind, followed by a squall, while a vessel is sailing, may cause her to capsize; for while she is apparently standing up well to the steady inclining force applied to her sails, she may have a comparatively small reserve of righting moment. Again, the waves have much more power over a vessel when her proportion of depth to breadth is small than when it is large; and, should she meet with waves of a period equal to her own, as is always possible, she may roll up to dangerous angles in a very short time. That this must be so will be clear when it is remembered that the influence of the waves increases with the square of the breadth, while, within ordinary limits, the inertia of the vessel varies approximately with the product of her breadth by her depth.

A vessel of this kind should have a curve of levers which cuts the base-line at not less than about 60 degrees. She will, under these conditions, be uncomfortable, but comfort must within reasonable limits be sacrificed to safety. The height of the center of gravity *G*, which must be aimed at in the distribution of the weights of the vessel, may be found as follows:

Assuming the curve of levers for zero *GM* height to have been obtained, say by the approximate method described, the distance below the base-line of a point in the curve at 60 degrees, divided by the sine of this angle, will give the *GM*

In small vessels it would be well to provide for a *GM* of about 12 to 15 inches, since they are at any time liable to meet with waves of the same period as their own, which may set up excessive rolling. Very large vessels with small *GM* height will probably have longer periods of rolling than the periods of any waves they are likely to encounter.

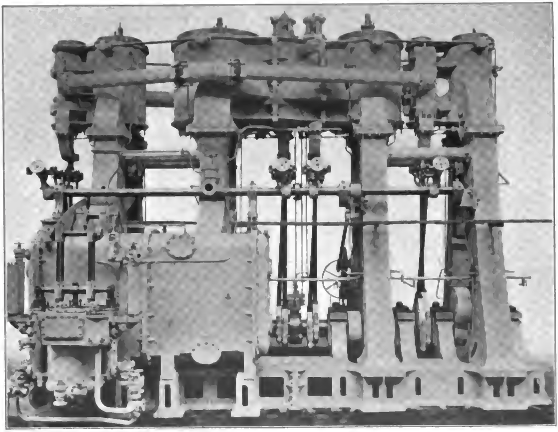
Low *GM* heights, such as those mentioned, make for steadiness and comfort at sea, but the vessels in which they occur must neither get into collision nor become leaky, and their captains must not attempt to run up broad water ballast tanks. Larger *GM* heights insure greater safety; but, after all, such safety is only a matter of degree, and the seagoing condition of a vessel is simply a balance of dangers and advantages. Neither absolute safety nor absolute comfort is as yet attainable.

Increased attention is beginning to be given to methods for the prevention of rolling, and it seems not unlikely that one or other of these may soon bring success in a commercial as well as in an engineering sense. Meanwhile the excessive rolling that results when the period of the waves synchronizes with that of the vessel may be mitigated, either by a change of the latter's course or by the expedient of partly filling or partly emptying a broad water ballast tank. Maneuvering with the water ballast tanks at sea in this way may, however, prove a dangerous experiment, and it is one that should be resorted to only in cases of emergency, and by men who are alive to its possible effects.

A small quantity of water introduced into a tank or bilge, or a small quantity pumped out of a full tank, may suffice to produce a fluid surface that does not regularly accompany the

motions of the vessel. Her period at once becomes altered, and, synchronism being thus destroyed, her rolling inclinations will be moderated. But it is a well-known rule that water ballast tanks should neither be filled nor emptied at sea, and to do so in the case of a tender vessel is, indeed, likely to prove disastrous. In a vessel of large stability, however, commanded by a man who knows what he is about, the operation above described might sometimes be resorted to with advantage.

Assuming perfect synchronism of periods, a vessel will heel further over with each successive wave, until either she capsizes or some new influence intervenes to alter her period. An influence of this kind comes into play when her gunwale becomes submerged and water gets on deck. The rolling motion is thus damped for awhile, and then gradually increases until the next dip takes place. But such a shipping of water may in itself be highly dangerous, and is in all cases objectionable.



BACK VIEW OF THE MAIN ENGINE OF THE NORSE PRINCE, SHOWING CONDENSER AND AIR AND CIRCULATING PUMPS.

A danger that is not always recognized lies in the wells of quarterdeck steamers, and in similar catch-water spaces on vessels of other types. Assume that a wave has filled the well to such a height that the water is free to preserve an approximately level surface while the vessel rolls. The effect of this is more than equivalent to that of the loss of a piece of the plane of flotation of like shape and size, since the center of gravity is at the same time raised. The height of the metacenter above the center of buoyancy being equal to

$$\frac{\text{Moment of inertia of waterplane}}{\text{Displacement of vessel}},$$

it will be seen that the loss may be a heavy one. It will perhaps be urged that the water runs off through the freeing ports; but, when these have the largest area possible, the time required to drain the well is very considerable, even if a second wave does not replenish the supply.

The perfection, which may now be hoped for, of some device for preventing or damping rolling, will shelve some of the most awkward problems of stability. Apart from the question of passengers' comfort, vessels provided with such devices will be less strained in a seaway, and less dependent upon wind and weather, and the safety of their crews will be promoted in a high degree. Whatever the device adopted, it will cost a certain amount of money and take up some space and weight, but it is highly probable that these disadvantages will be more than counterbalanced by reductions in coal bills, increase of speed in rough weather, and comparative absence of wear and tear in the structure.

The Steamship Norse Prince.

There was launched on Sept. 10, 1907, from the yard of Palmer's Shipbuilding & Iron Company, Ltd., Jarrow, a handsomely modeled steel screw steamer of the following dimensions:

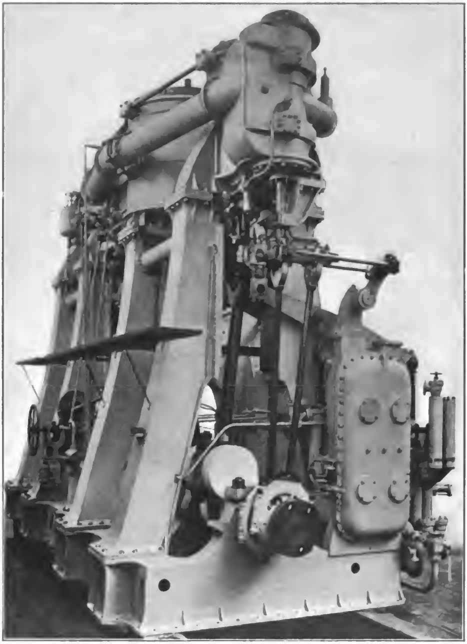
Length between perpendiculars....	420 feet
Breadth molded..................	54 feet
Depth molded....................	31 feet 1 inch

The vessel has been built of steel, with the usual parts of iron, to the highest class in Lloyd's Register; she is of the three-deck type, having a continuous shelter deck all fore and aft. The main, upper and shelter decks are of steel all fore and aft, the latter being wood sheathed. Accommodation is fitted in steel deckhouses on the shelter deck amidships for captain, officers and twenty-four first class passengers; the crew being located under the shelter deck forward. The shelter deck and 'tween decks are fitted with side lights and

ventilation necessary to enable the vessel to carry cattle or emigrants.

The vessel is divided by eight watertight steel bulkheads. She is fitted with cellular double bottom for water ballast, extending all fore and aft except under the boilers; water ballast being also contained in a deep tank abaft the engine room, extending to the main deck and in fore and after peaks. The ship is rigged as a two-masted fore-and-aft schooner, and a very complete system of winches and derricks is provided for expeditiously loading and discharging. Electric light is fitted throughout, and a direct steam windlass is placed forward for working the anchors; the steam steering gear being fitted in wheelhouse aft, and geared direct onto the tiller.

There is one quadruple expansion engine, having cylinders 24½, 35, 51 and 74 inches in diameter by 51-inch stroke, provided with steam by three boilers, 14 feet 9 inches in diameter by 11 feet 9 inches long, at 220 pounds per square inch working pressure, under Howden's forced draft. Generally, the vessel, which will load over 9,000 tons deadweight, is equipped with all modern conveniences to fit her as a first class cargo and passenger steamer.



THE MAIN ENGINE OF THE STEAMSHIP NORSE PRINCE, SHOWING HANDLING GEAR.

The North Dakota, the third of the American all-big-gun battleships, is to be launched by the Fore River Shipbuilding Company on Nov. 10, being about 60 percent completed. The normal displacement is 20,000 tons, on a draft of 26 feet 11 inches, the length on waterline being 510 feet, and beam 85 feet molded. She carries ten 12-inch guns in pairs in five turrets on the center line, all bearing on one broadside. Propulsion is by twin screws, operated by Curtis turbines of 25,000 horsepower.

THE HEATING AND VENTILATING OF SHIPS.

BY SYDNEY F. WALKER, M. I. E. E.

THE HEATING BY ELECTRICITY OF A LARGE PASSENGER STEAMER.

The writer has outlined a scheme for heating a large passenger steamer throughout by electrical apparatus, and he has selected for the purpose the North German Lloyd steamer *Kaiser Wilhelm der Grosse*, which has a displacement of 20,000 tons, carries a crew of 450, and has accommodation for 1,500 passengers—first, second and third class. Her dimensions are: Length, 625 feet; breadth, 66 feet; depth, 43 feet. It will be understood that a scheme of the kind can be only approximate. As engineers know well, the figures for each case, in engineering practice, have to be worked out by themselves, and the present writer has not the whole of the necessary figures before him to enable him to make an exact estimate. The figures will, however, he believes, be sufficiently accurate to show what can be done by electrical heating apparatus, and what it is likely to cost. The writer has also taken into account in the heating appliances only the passenger accommodation and its accessories.

The *Kaiser Wilhelm der Grosse* has:

A first class dining saloon, measuring 110 by 65 feet, placed amidships on the main deck; a second class dining saloon, measuring 50 by 55 feet, aft on the main deck; a children's saloon, measuring 44 by 26 feet, aft on the main deck; a children's dining saloon, measuring 45 by 30 feet, forward on the main deck; an auxiliary second class dining saloon, 50 by 15 feet, aft on the upper deck; a first class drawing room, 32 by 30 feet, amidships on the promenade deck; a second class drawing room, 25 by 20 feet, aft on the upper deck; a first class smoke room, 33 by 40 feet, forward on the promenade deck; a second class smoke room, 38 by 26 feet, aft on the promenade deck; a reading room, 30 by 20 feet, forward on the promenade deck.

It has also accommodation for third class passengers on the lower deck totaling 200 by 34 feet; also for stewards for third class passengers on the lower deck totaling 120 by 20 feet; accommodation for third class passengers on the main deck, 42 by 40 feet; accommodation for attendants on the main deck, 40 by 20 feet.

In addition there are some 260 spaces to be heated, comprising staterooms, hospitals, kitchens, pantries, lavatories, etc., and there are the usual vestibules to the saloon, in which the stairs leading from one deck to the other in the passenger departments are fixed.

The height between decks for the promenade, upper and main decks, is 8 feet, and that of the lower deck is 7 feet. There is the usual orlop deck, but it is occupied mainly by boilers, coal bunkers, cargo, baggage, chain lockers, etc.

The writer has divided the staterooms and similar spaces into two sizes to simplify the calculations. One lot, of which he makes out that there are approximately 100, measure 10 by 10 feet by 8 feet high. The smaller ones, of which there are about 160, measure 8 by 6 feet by 8 feet high.

In calculating the heating apparatus required and the quantity of current to furnish the necessary heat, the writer has worked to the same figures as were used in explaining how to calculate the quantity of heat that must be provided by any heating apparatus to make up for the heat lost by passing out through the sides of the ship, the bulkheads of cabins, saloons, etc., and the decks above and below. The problem, it will be seen, is similar to that which the refrigeration engineer has to deal with. In the case of cold storage the problem is to carry off the heat that passes in through the walls, decks, etc., of the cold chamber. In the present case the problem is to deliver heat to the rooms to be warmed, to make up for that which has passed *out* through the walls, decks, etc.

To estimate the quantity of heat that must be delivered by any heating appliance, the quantity of heat passing out of the room to be warmed must be estimated by taking the surfaces through which heat can escape, the quantity of heat escaping per square foot, and the difference of temperature between the inside and the outside. The rate of passage outwards of heat the writer has taken at the figure given in a previous article, 0.5 British thermal unit per hour per square foot per degree F. difference of temperature between the inside and the outside; with one exception, that of the skylights of the first class dining saloon and the first class drawing room. The rate at which heat passes through glass is very much higher than that at which it passes through wood, and it has been assumed, in all the calculations, that wood is the substance through which the heat from the saloons, state rooms, etc., has to escape, except in the case of the skylights mentioned.

The writer has also taken the figures mentioned in a previous section, viz.: a minimum temperature of 30 degrees F. outside the ship and a temperature to be maintained in the rooms to be warmed of 70 degrees F. In a great deal of the passenger service the minimum temperature mentioned, 30 degrees F., will not be reached. Probably a temperature of 40 degrees F. would be more like the average, but even crossing the Atlantic in winter very much lower temperatures are met with. The calculation is intended as a guide only, and must be altered to suit the temperatures, and it is a very simple matter to do so. Thus, the extreme range of temperature taken in the writer's calculations is a difference of 40 degrees F. For ships which meet temperatures of 20 degrees F. an addition of 25 percent to the heat required to be delivered will be necessary, and to the heat-furnishing appliance. To ships meeting temperatures of 10 degrees F. an addition of 50 percent to the writer's figures will be required. For the average minimum of 40 degrees F., which will probably meet the case of a large number of ships, the writer's figures may be reduced by 25 percent.

It should also be noted that the writer has taken 70 degrees F. as his standard of temperature within the rooms to be warmed, this being the temperature to which Americans are accustomed. Europeans are accustomed to take standard temperatures of 60 degrees, or at most 65 degrees F. For those ships where a standard of 60 degrees F. would be sufficient for living places the writer's figures may again be reduced by 25 percent.

In drawing his estimate, also, the writer has assumed that the heating appliances would be placed in the best position for distributing the heat to the best advantage. On board ship there is not the same trouble as on shore with chimneys, except in those saloons that are furnished with grates, fires and so on, and therefore there is not the danger of the heat liberated by the heating appliance being carried off up the chimney. Ventilation, of course, must be provided, and, as already indicated, the best method is to place the heating appliance in the path of the ventilating air current, where it enters the room to be warmed. Where there is no special ventilating arrangement the heating appliances should be placed as far as possible in the line of the natural ventilating air current, the air which comes in under doors and by other openings as it enters the room.

There are two or three important points that should be noted in connection with the calculations for the size of heating appliance required and the quantity of current. Thus, of the two sizes of staterooms, the larger measuring 10 by 10 feet by 8 feet, or 800 cubic feet, and the smaller 8 by 6 feet by 8 feet, or 384 cubic feet, say 400 cubic feet in round figures; owing to the much larger surface in the 10-foot rooms above that exposed in the 8-foot rooms, the amount of heat passing out through the walls, etc., and the amount of heat therefore required to be delivered to the air of the rooms to make it up, is enormously larger for the large rooms than for the smaller, as will be explained.

In the present case, also, the first class dining room and drawing room are exceptionally well placed, as far as the requirement of heating appliances is concerned, because they lie between two funnels. The funnels, of course, are protected on the outside, so that the passage of heat outwards is a minimum, but the writer has assumed that a certain quantity of heat does pass from the funnel casing into the dining and drawing rooms. It is a case of heat passing into these rooms in place of passing out of them, and the quantity of heat that has to be delivered by any heating apparatus to these rooms is lessened by the heat delivered from the funnels. In estimating the heat required for the dining saloon the writer has taken the heat passing out through the ship's side, the decks above and below and the skylight, and has subtracted from it the heat he estimates will pass in from the funnel casing. In the case also of the alleyways, as the engine-room funnel and stoke-hold casings will line the alleyways for a large portion of the length of the ship, and as a considerable amount of heat must pass from them into the alleyways, the writer has assumed that the temperature of the air in the alleyways will be raised 10 degrees above that of the air outside during cold weather.

APPARATUS ESTIMATED TO BE REQUIRED FOR HEATING THE DIFFERENT SALOONS, STATE CABINS, ETC.

The electrical heating appliances, it was explained, are made in various sizes to absorb from 200 watts up to 6,000 watts. These heating appliances, it will be remembered, are divided into two distinct varieties, those in which the long incandescent electric lamps are employed and those in which non-luminous resistances are employed. The lamps are usually arranged to absorb 250 watts each, though the Prometheus Company, of Great Britain, has recently introduced lamps taking 350 watts, and burning at a red heat in place of a yellow heat. The 250-watt lamp, however, forms a very convenient standard, particularly as it is made up into appliances carrying 2, 3 and 4 lamps, and in the following estimate the writer gives the figures in watts required and in lamps of 250 watts each:

The first class dining saloon requires the expenditure of 4,500 watts, or 18 lamps. The first class drawing room requires the expenditure of 1,400 watts, or 6 lamps. The second class dining room requires 3,500 watts, or 14 lamps. The children's dining room requires 3,000 watts, or 12 lamps. The children's saloon requires 2,500 watts, or 10 lamps. The auxiliary second class saloon requires 1,250 watts, or 5 lamps. The first class smoke room requires 2,000 watts, or 8 lamps. The second class smoke room requires 1,500 watts, or 6 lamps. The reading room requires the expenditure of 1,000 watts, or 4 lamps. The third class passengers' quarters, stewards, attendants, etc., require 6,000 watts, or 24 lamps.

The large staterooms, the writer makes out, require 2,500 watts, or 10 lamps, and the smaller staterooms 250 watts, or even less, or 1 lamp. Taking the number of the larger staterooms at 100, this means 1,000 lamps in addition, and the number of the smaller rooms at 160 means 160 more lamps. In addition to the above there are the vestibules mentioned.

The total number of 250-watt lamps given in the above list is 1,267, and it will therefore be wise to allow for a total, to cover all contingencies, of 1,500 lamps of 250 watts, or for a current of 375 kilowatts.

The above figures are for the minimum outside temperature mentioned, 30 degrees F. If a temperature of 20 degrees F. has to be provided for 1,875 lamps, or say a current of 470 kilowatts, would be required. With a temperature of 10 degrees F., 2,250 lamps and a current of 565 kilowatts would be required. With a temperature of 30 degrees below zero F., or 100 degrees F. difference between the outside and the rooms to be warmed, 3,750 lamps would be required, and a plant capable of furnishing 940 kilowatts, or about 1,250 horsepower.

THE COST OF FURNISHING THE HEAT REQUIRED.

So far as the writer has been able to ascertain, no figures have yet been accurately taken out giving the cost of generating current on board ship. With electric lighting as an auxiliary the steam required has gone in with other auxiliaries. On the other hand, it is often not the rule to condense the steam used by auxiliaries, and the consumption of electric light engines is taken at about 40 pounds of steam per kilowatt-hour. But it must be remembered that the steam is being generated under the most economical conditions. The steamer crossing the Atlantic, or at sea for any number of days, under any possible conditions, providing she is continuously steaming, is generating steam under the most favorable conditions known to the engineer. There are practically no stand-by losses, such as send up the fuel cost so much on shore.

On shore, it will be remembered, lighting is required only for a certain number of hours during the day, and power even is required only for a certain number of hours, and there are portions of the day, both with lighting and with such power services as that for tramways and suburban railways, when the quantity of current is very high indeed for a short time, dropping to something very small between those times. This means that either boiler furnaces have to be banked or they have to be let out and relighted. In either case it means the consumption of a considerable quantity of fuel not required in steamship work. Further, the oil and petty stores and other things required for electrical generating plant on board ship, are part only of a large whole, and therefore should be obtained more economically, providing proper care is used in issuing stores, than where the plant, often a comparatively small one, has to buy everything specially for its own use.

The attendance, also, in the case of a shipboard electricity generating plant, should be smaller than for a similar plant on shore. Boiler attendance goes in with that of the main engines. Even a very large electricity generating plant will not make much appreciable difference to the stoke-hold labor of a ship of 20,000 tons and of 27,000 horsepower, such as the *Kaiser Wilhelm der Grosse*. Attendance, in fact, is resolved into that of the electrician on watch, with possibly an assistant to oil, and the electrician to look after the apparatus in use, to make good little breakages, keep switches right, etc.

The writer thinks that he will not err on the side of optimism if he takes the cost of electricity at 0.5d. (one cent) per kilowatt-hour (Board of Trade unit, as it is called on shore in the United Kingdom). In America there are many electrical generating plants, generating current for railways and other purposes, in which the cost is very much less than the figure taken above, and there are cases even in the United Kingdom of electrical generating plants at collieries and in other works where the cost of generation is much less than 0.5d. If the above figure is taken, therefore, any estimates founded upon it should be fairly safe.

The heating appliances detailed for the different saloons, etc., total up to 107 lamps of 250 watts each. These heating appliances will probably be required from 8 A. M. to midnight, or say 16 hours, and in addition a certain number of the smaller staterooms, and possibly a few of the larger ones, will probably be required during the same hours, and therefore it will probably be approximately correct to assume 240 lamps of 250 watts each as being employed for 16 hours per day. This means 60 kilowatts for 16 hours, or 960 kilowatt-hours per day. The writer estimates that probably 60 lamps of 250 watts will be required for the full 24 hours; this equals 15 kilowatts for 24 hours, or 360 kilowatt-hours. Of the remainder, the staterooms and other places will be required for probably 4 hours during the day. In addition there will be some 1,200 lamps of 250 kilowatts, or the equivalent, which will probably be required for 4 hours out of the 24.

This means 300 kilowatts for 4 hours, and equals 1,200 kilowatt-hours. Adding these together, the total is 2,520 kilowatt-hours per day.

This would cost, at 0.5d. per kilowatt, £5.5.0 ($25.55) per day, or say £31.10.0 ($153.30) for a six-day passage across the Atlantic. If 20 degrees F. is taken as the minimum temperature the total cost will be £39.7.6 ($191.62) for the trip; if 10 degrees F. is the minimum, £47.5.0 ($229.95), and for lower figures in proportion. For ships trading to very cold climates, and where economy is essential, where also the heating would be required for months together, the cost would probably be prohibitive in the great majority of ships. With a temperature of — 30 degrees F., or 100 degrees F. difference, the cost of heating would be £13.2.6. ($63.88) per day for a ship of the size of the *Kaiser Wilhelm der Grosse*, and with its crew and passengers. But as ships which go on whaling cruises do not carry passengers nor large crews, electric heating even then might be found economical, on account of its convenience, in some cases.

The heating can be carried out at less cost by the steam or hot water appliances that have been named, but as in so many other things the great convenience of the electrical method of distribution and of control more than counterbalances the increased cost, which, as will be seen, is but a very trifling sum, as against the whole cost of running a steamship of the size of the *Kaiser Wilhelm der Grosse* across the Atlantic. There are, of course, other points to be considered. Additional plant will be required to furnish the current, and it would probably not be safe to have less than 500 kilowatts for the special heating appliances in the case of the ship considered, and under the conditions named, and larger plant in proportion for the lower temperatures.

There is the question of finding room for a 500-kilowatt plant and the larger plant where required, though with turbo-generators this question is reduced to a minimum. There is also the question of the additional cables. Already the cable problem is a somewhat serious one in connection with lighting, and the addition to it of the requirements for heating will increase the trouble. There is no reason, however, that the heating current should not be taken off the lighting service, and, providing the conductors for the lighting service are properly divided up, as they always are in modern steamships, so that it is hardly possible for all the lights to be out at once, the trouble of the increased size of the conductor will not be so great. When a cable reaches a certain size a comparatively small addition in diameter gives it a considerably increased conducting power.

For the lower temperatures the cable question would be more serious. Everything, first cost and running cost, increases as lower and lower temperatures have to be provided for; but, again, in the case of the whaler, as the whole plant would be small, the matter need not be very serious.

Steam Turbines in the German Navy.

In no country has the marine turbine met with more bitter criticism or such a thoroughly hostile reception as in Germany. Unlike marine engineers in nearly all other countries, who tactfully reserved their judgments, the German naval authorities and the responsible officials of the large steamship lines condemned the entire system at the beginning, in no measured terms and on utterly insufficient grounds. It is a matter of some speculation, therefore, as to how some of these gentlemen can reconcile their consciences with the recent orders for turbine warships, or maintain their attitude in spite of the results obtained from certain naval vessels.

Almost simultaneously with the British Admiralty orders for the cruiser *Amethyst* and destroyer *Eden*, the German Government ordered a similar type of cruiser—the *Lübeck*—and a somewhat similar destroyer—*S125*—from the Vulkan and Schichau yards, respectively, in order to gain experience of the Parsons system. About the same time, the Hamburg-American Line had constructed at the Vulkan works the steamship *Kaiser** for their Hamburg to Heligoland service, which was fitted with Curtis turbines. Both the *Lübeck* and *S125* were subjected to comparative trials with sister ships, and each vessel was tried with several different sets of propellers. Some results from the *Lübeck* are given in Tables I. and II., while the figures for *S125*, and also for the larger destroyer by which she was succeeded—*G137*—are given in Table III. The *Lübeck* has four shafts.

Early in 1906, in spite of considerable criticism, a similar ship to the *Lübeck*—the *Stettin*—of slightly greater dimensions, was also ordered to be fitted with turbines, and yet a third of the series—the *Ersatz Comet*—was commenced early in 1907, at the works of Messrs. Blohm & Voss, at Hamburg. The small cruisers, however, ordered late in 1907, will be of a more experimental nature. The *Ersatz Greif*, building at Schichau's works at Dantzig, is being fitted with turbines of the Melms and Pfenniger type—a modification of the Parsons system whereby a shorter turbine is obtained. The two sister ships building at the Vulkan and the Germania Works will be fitted with Curtis and Zoelly turbines, respectively. It will be a matter of considerable interest to note how these different systems compare with one another.

The largest order placed, however, for turbine machinery is that for cruiser *F*, the German reply to the British *Inflexible* class. Details concerning this vessel are extremely meager, but her displacement of 19,500 tons is significant. There is little doubt that she will be constructed with all the secrecy and dispatch possible. She is to be ready before the end of 1909. No battleships have, as yet, been ordered with turbines, the four ships laid down early in 1907—the *Ersatz Sachsen* class—having the usual arrangement of triple screws and reciprocating engines.

In Table IV. are given the leading particulars of the vessels in the German navy fitted with turbines. No merchant steamers have as yet been built with Parsons turbines; of the two that have been constructed with turbine machinery, one has had Curtis and the other Zoelly turbines.

Table I.—Propellers.

Set	Propellers	Diameter	Pitch	Pitch Ratio	Projected Area	Ratio Projected / Disk Area
1	8 small	54.0"	54.0"	1.0	6.37 sq. ft.	0.4
2	4 large	66.9	58.8	0.88	9.5	0.39
3	4 mixed	(a) 62.9	56.4	0.896	12.9	0.6
		(b) 68.8	61.9	0.898	15.5	0.6

(a) One on each outer shaft. (b) One on each inner shaft.

Table II.—Speed and Power Results.

Propellers	Speed	Horsepower	Slip, percent	R.P.M.	Remarks
Set 1......	22.37	13,705	25.11	672	
Set 2......	22.39	13,029	25.97	623	Shallow water.
Set 2......	23.16	14,158	26.5	...	Deep water.
Set 2a......	22.56	13,573	15.51 for'd 22.67 aft.	601	Four screws of Set 1 forward, with four of Set 2 aft.
Set 3......	22.55	13,579	25.79	625	

The displacements on these trials were between 3,200 and 3,300 tons. The horsepowers are *torsional* horsepowers, and were taken by the Föttinger torsion meter. The revolutions are the mean of the four shafts. Assuming the equivalent "indicated" horsepower to be 10 percent greater than the torsional horsepower, and the mean displacement to be 3,250

* See page 473, December, 1906.

tons, the Admiralty coefficients for these five sets of trials become 162.4, 171.2, 174.5, 168.1 and 164.2, respectively.

Table III.—Turbine and Reciprocating Engined Destroyers.

Vessel	Speed	Displacement	Horsepower	R.P.M.
(*a*) *S*120–124......	27.5	300	6,850	300
*S*125...........	26.6	440	7,000†	875
*S*131...........	29.6	525	10,250	305
*G*137...........	33.09	570	13,000†	900

The *S* 120-125 class were completed in 1905, and the 131-137 vessels in 1907. (*a*) Sister ships to the turbine vessels, but fitted with reciprocating engines. †Estimated.

Table IV.—Turbine Warships in the German Navy.

Vessel	Date of Trials	Length	Beam	Draft	Displacement	Horsepower	Speed
*S*125	1905	205′	23′–0″	7′–0″	440	7,000	26.6*
Lubeck......	1905	341	43 –0	16 –5	3,200	14,000	23.0*
*G*137..........	1907	232	24 –9	7 –10	570	13,000	33.09*
Stettin	1907	300	43 –6	16 –0	3,400	15,000	25.8*
Dresden......	1908	365	44 –3	16 –0	3,600	17,500	25.0
Ersatz Greif..	(*a*) (*b*)	....	....	....	4,300	20,000	25.5
Cruiser *F*	(*a*)	530	85 –6	27 –0	19,600	44,000	24.25

* Speed on trial. (*a*) Ordered, October, 1907. (*b*) Three ships.

CLYDE RUDDERS AND RUDDER POSTS.

Fig. 1 shows the general practice of sternpost and rudder for the usual paddle steamer of 210 feet between perpendiculars by 25 feet beam by 9 feet molded depth. It will be seen that the rudder frame, stock and arms form one complete forging. The sternpost is also a forging, and is scarfed to the bar keel two and one-half frame spaces from the after perpendicular. The rudder stock is 4½ inches diameter, bushed at deck and top of cants, a distance of 5 feet 4 inches above load waterline; above the stock at upper bush a brass cap is fitted when the portable tiller is not required.

A quadrant is fitted above the cant frames, of the three-legged type, with a radius of 3 feet 6 inches. The legs are set to angles of 40 degrees. The boss is 8½ inches over all by 4 inches deep; 2 inches of metal are thus left on each side of the stock. The legs are 3¼ inches wide by 2½ inches deep at boss, and 2½ inches wide by 2 inches deep at palms. The palms are 7 inches deep by ⅝ inch thick. At the boss of tiller two snugs are fitted, to take 1¼-inch screws; to the screws are fitted the steering chains. A plate, 7½ inches deep by ⅜ inch thick, with double angles 3½ by 3½ by 7/16 inches, is riveted to palms of quadrant legs. On upper side of plate are riveted four horns, to prevent the chain from jumping.

The rudder arms are part of the forging. They are 4 inches

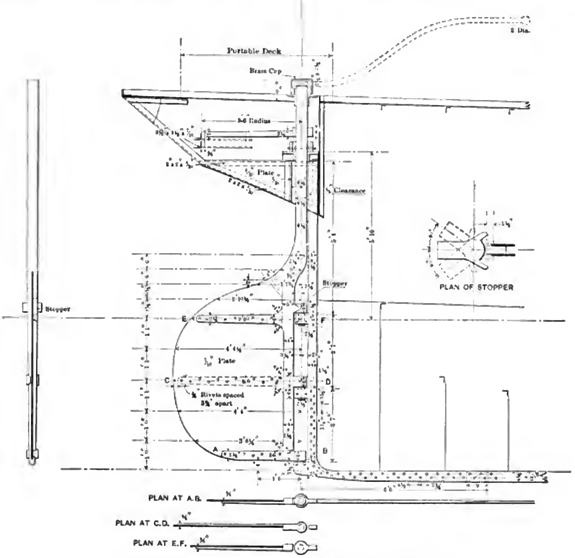


Fig. 1.—Sternpost and Rudder for Paddle Steamer 210 Feet by 25 Feet by 9 Feet.

deep at fore side, 2½ inches deep at after side, and ⅝ inch thick at after end (see plan *C D*). The rivets through arms and rudder plate are ¾ inch diameter, spaced 3¾ inches apart. The rudder plate is of mild steel, 7/16 inch thick. The pintles are three in number, spaced 2 feet 7 inches apart; the diameters are 2½ inches. This leaves 1½ inches metal on each side of gudgeon. From underside of pintle bracket to top of gudgeon there is ½ inch clearance, and between gudgeon and rudder frame the clearance is ½ inch; between pintle bracket and sternpost the clearance is ½ inch. The lower pintle rests on a steel cap. The distance from center of pintles to rudder frame is 3⅛ inches, and from sternpost to center of pintles is 2¾ inches.

A detail sketch is shown of stopper, enabling the rudder to work through an arc of 80 degrees; the detail shows an arrangement which has found favor with ship owners. Another form of stopper in common use is made by fitting lugs to sternpost.

The sternframe is a forging, connected to bar keel by a scarf 9 inches long and 6 feet 6 inches from center of pintles. The gudgeons on it are 4 inches deep.

The top of sternpost is 5 feet 4 inches above load waterline, and is connected to 5/20-inch transom plate by double angles 2½ by 2½ by 5/20 inches. The rivets in vertical part of sternpost are ⅝ inch diameter, spaced 3½ inches apart (reeled). The rivets in sternpost in a fore-and-aft direction are ¾ inch diameter, spaced 4½ inches apart (reeled). The bar keel is 4½ by 13/16 inches.

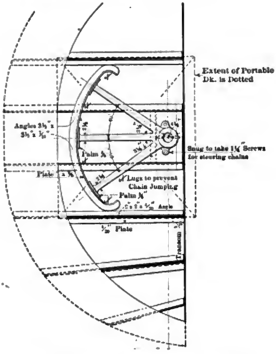
The rudder trunk is formed as follows:

Fore end, 5/20-inch transom plate.

After end, 4/20-inch plate, 4½ inches aft of center of rudder stock.

Sides, cant frames, 12 inches each side of center line.

Top, 6/20-inch plate, to take rudder bush.



PLAN OF QUADRANT FOR 210-FOOT PADDLE STEAMER.

It will be noticed on plan that deck is portable above quadrant; the portable portion is indicated by dotted lines.

Fig 2 shows the sternpost and rudder of a single screw steam yacht 162 feet on the waterline. The rudder

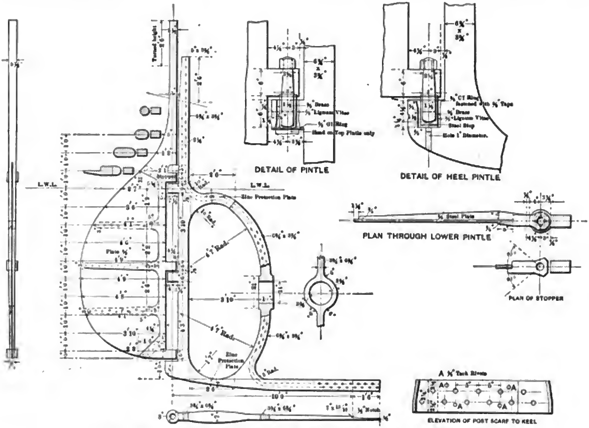


FIG. 2.—STERNPOST AND RUDDER OF SINGLE-SCREW STEAM YACHT 162 FEET ON THE WATERLINE.

frame and arms form one complete forging. The rudder stock is 5½ inches diameter, and this diameter is kept down to stopper, when a gradual taper commences, finishing at bottom pintle with a width of 3 inches. The rudder frame tapers in a fore-and-after direction from 5 inches to 4¼ inches. The arms are three in number, and are part of rudder frame. The upper arm is 21 inches below load waterline; the middle arm is 2 feet 9 inches below upper arm; the lower arm is 2 feet 6 inches below middle arm. The arms are 5 inches deep by 3 inches thick at fore end, tapering to 3 inches at after end by ¾ inch thick. A detailed sketch post to center of pintle is 3⅞ inches, and from center of pintle to fore end of rudder frame 4⅞ inches. The clearance between bottom pintle bracket and lower gudgeon is 1 inch. The distance that bottom pintle is sunk into bottom gudgeon is 4½ inches, and 1¼ inches of steel cap is allowed for.

The rudder is arranged to work through an arc of 80 degrees before stopper is brought to bear hard against sternpost (see detail of stopper). From underside of bottom pintle to top of rudder stock the distance is 19 feet. The sternpost and propeller shaft post form one forging, 6¼ by 3¼ inches, scarfed to a bar keel 7 by 1 13/16 inches (as shown in detail).

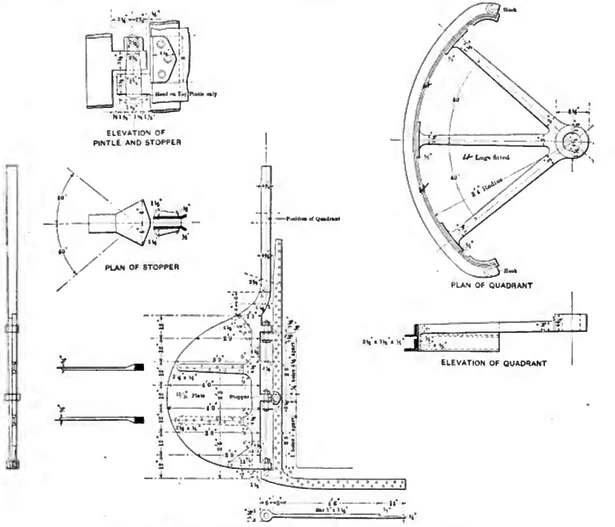


FIG. 3.—STERNPOST AND RUDDER FOR PADDLE STEAMER 165 FEET LONG BETWEEN PERPENDICULARS.

is given showing a plan through lower pintles. The rivets connecting arms to rudder plate are 1 inch diameter, spaced 5 inches apart. The rudder plate is ⅝ inch thick.

The three pintles are 3 inches diameter through gudgeons, tapering to 2⅝ inches. Each pintle is bushed with ⅜-inch brass and ⅝-inch lignum vitæ. ½-inch plate is fitted at bottom of upper and lower pintles, attached to gudgeons with ⅜-inch taps. A head is fitted on top pintle only (see detail). The bottom pintle rests on a steel cap as shown; the diameter and bushing are the same as for upper and lower pintles.

It will be noticed on detail that the lignum vitæ bush is slightly wedged. The pintle brackets and gudgeons are 6 inches deep. The clearances all around between rudder frame and sternpost are ⅞ inch. The distance from after side of The bottom of the aperture is flattened to 7 by 4 inches. The aperture in sternpost is 3 feet 10 inches wide by 9 feet 9 inches deep. The boss is 10 inches wide by 3¾ inches thick, and 21 inches over all. The 14-inch diameter is a rough bore only. The rivets in propeller post and part of sternpost are 1 inch diameter, spaced 5 inches apart, and the distance between centers in a fore-and-aft direction is 2¼ inches. The sternpost is carried up 30 inches above line of counter. Zinc protection plates are fitted for a length of 30 inches at top and bottom of aperture.

Fig. 3 shows the sternpost and rudder for a small paddle steamer 165 feet long between perpendiculars. The rudder stock frame and arms form one complete forging. The rudder stock is 4¾ inches diameter; this diameter is kept to

upper pintle, whence the thickness is gradually reduced to 3 inches at lower pintle. The arms are 27 inches apart, and taper in depth from 4½ inches at rudder frame to 2½ inches at end of rudder. The fastenings through arms and rudder plate are ⅞-inch diameter rivets, spaced 5 diameters apart (reeled). The three pintles are 2¾ inches diameter.

The spacing of gudgeons is 2 feet 8 inches apart; the depth of gudgeons and pintle brackets is 3½ inches. The clearance all around between rudder and sternpost is ½ inch, and the space between rudder and sternpost is 6½ inches. The centers of pintles are 3¼ inches from sternpost and 3¼ inches from end of rudder frame.

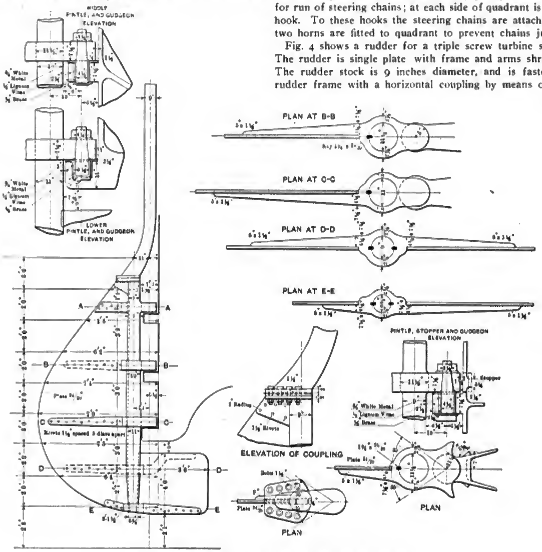


FIG. 4.—RUDDER AND DETAILS FOR A TRIPLE-SCREW TURBINE STEAMER.

A detail sketch of pintle, gudgeon and stopper is shown. This form of stopper shows a lug riveted to sternpost with three rivets. The lug is 8 inches long, 4½ inches broad, 1½ inches thick at after end and ½ inch at fore end. The stopper is on lower pintle, and is arranged to allow rudder to work through an angle of 80 degrees. The rudder plate is 12/20 inch thick.

The sternpost is a forging 10 feet 6 inches over all, of 5 by 1½-inch section. The rivets in upper part are ⅞ inch diameter, spaced 4⅜ inches apart; in lower portion the rivets are 1 inch diameter, spaced 5 inches apart. This spacing is continued to bar keel. The length of sternpost in a fore-and-aft direction is 5 feet 3 inches.

The quadrant is of the three-legged type, with legs at an angle of 40 degrees. The radius of quadrant is 3 feet 4 inches. The legs at boss are all 3 inches wide by 2½ inches thick, and 2½ inches wide by 2 inches thick at palm. The palms are 7 inches deep by ⅝ inch thick. The boss is 8½ inches diameter by 4¾ inches thick. After deducting 4¾ inches for diameter of rudder stock this leaves 1⅞ inches on each side of stock.

To palms of quadrant legs is riveted a 7 by ⅜-inch plate; and to the plate are riveted two 3½ by 3½ by ½-inch angles for run of steering chains; at each side of quadrant is fitted a hook. To these hooks the steering chains are attached, and two horns are fitted to quadrant to prevent chains jumping.

Fig. 4 shows a rudder for a triple screw turbine steamer. The rudder is single plate with frame and arms shrunk on. The rudder stock is 9 inches diameter, and is fastened to rudder frame with a horizontal coupling by means of eight 1½-inch turned bolts, and a tapered key, 2¼ and 2 inches by 1⅛ inches thick, is driven up the center of the coupling. The coupling is fitted above the waterline, so that the rudder can be unshipped without in any way interfering with the steering gear. The diameter of rudder frame at coupling is 9 inches; at middle pintle 10 inches; at bottom pintle 11 inches, and at bottom of rudder 6¾ inches.

The arms are shrunk on and secured against rotation by keys. A longitudinal groove for the plate serves as a keyway for the arms. The five arms are spaced from 3 feet 9 inches to 2 feet 7 inches apart. They are 7½ inches deep at rudder frame, and vary in thickness from 4⅛ to 4½ inches. At the end of the rudder they are 5 inches deep and 1½ inches thick. The thickness of arm bosses varies from 2⅞ to 3 inches.

The upper and lower pintles are 4½ inches diameter

through gudgeons; then the diameter is reduced to 3½ inches. The diameter of bottom pintle is 5½ inches, and tapers to 4¼ inches. This pintle rests on a steel button. A split pin is fitted above nut of each pintle. A head is fitted on upper pintle only. The pintles are bushed as follows: ½ inch brass, ½ inch lignum vitæ, with ¼ inch white metal tapped on to top of gudgeons. The rivets for connecting arms to rudder plate are 1⅛ inches diameter, spaced 5⅝ inches apart. The thickness of rudder plate is 24/20 inch.

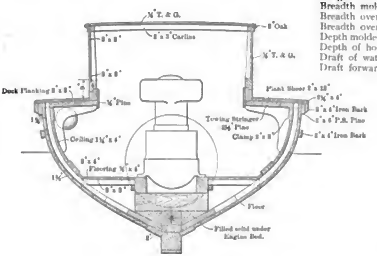
The distance from sternpost to center of pintles is 6½ inches, and from center of pintle to center of rudder frame is 13 inches. The clearance between rudder frame and sternpost at bottom pintle is 1 inch; at upper and lower pintles the clearance between sternpost and arms is 1½ inches; between gudgeon and rudder frame 2½ inches. The stopper is arranged to allow the rudder to work through an arc of 70 degrees.

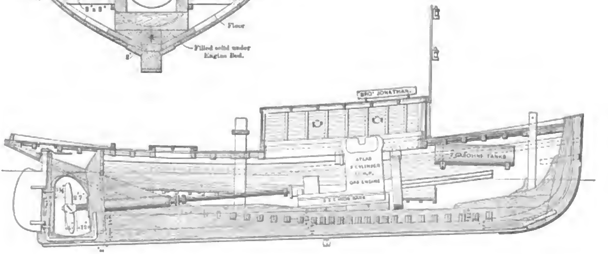
The Gasoline Towboat Brother Jonathan.

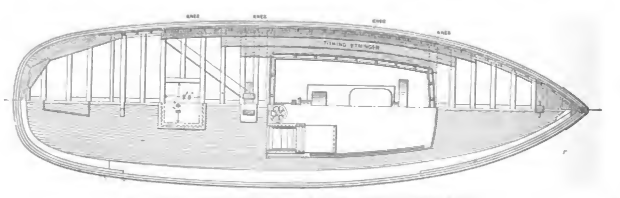
The use of the internal combustion engine for marine motive power in towboats is growing rapidly. One of the latest examples is the new gas tug *Brother Jonathan*, designed by D. W. & R. Z. Dickie, San Francisco, for James Wilder, and used in towing work in San Francisco bay. This type of boat has been developed by Mr. Wilder after many years of experience in operating boats of different types, and has proved very successful for towing barges, schooners and general small towing work.

Most of the towing is done on a headline, so the main towing bit is placed well forward to facilitate handling. The hull is of strong, plain construction, well fastened throughout with galvanized iron, the general dimensions being as follows:

	Feet.	Inches.
Length from forward side of stem to after side of stern post	37	10
Length over all	42	10
Breadth molded	11	3½
Breadth over planking	11	7
Breadth over guards	12	3
Depth molded, top of keel to top of beams at side	5	4
Depth of hold	4	6
Draft of water, aft, complete	5	6
Draft forward, 3 feet 11 inches; mean	4	8½







MIDSHIP SECTION, INBOARD PROFILE AND PLAN OF GASOLINE TOWBOAT BROTHER JONATHAN.

SIDE VIEW OF THE BROTHER JONATHAN.

The hull is short, to enable the boat to turn easily between the wharves. The steering, reversing and governing are all controlled by auto gear, the boat being easily handled by one man.

The lumber used for planking, decking, ceiling and housing is No. 1 Puget Sound pine. The stem stern post, rudder, rudder post, cleats and bits are of oak. The main, lower and nose guards are of iron bark. Five natural knees are fitted on each side, as shown on the plan, through fastened through deck beams and deck and frames and outside planking, which makes the boat very solid. The crown of deck beams is 4 inches in the width of 11 feet 7 inches.

The engine is of the two-cylinder heavy duty marine type, built by the Atlas Gas Engine Company, San Francisco, and develops 75 brake horsepower at 320 revolutions per minute, running on "No. 2" distillate. When running light the engine makes 320 revolutions per minute, turning a four-bladed elliptical propeller of 46 inches diameter, 40 inches pitch and 33 percent surface ratio, driving the boat at a speed of 10 miles per hour. The boat is too short for speed, the photographs showing excessive bow wave when running at full speed.

Type of engine (75 horsepower) ..	Steam	Gas
Fuel used......................	Crude oil	Distillate
Price of fuel.....................	$1.25 per bbl.	7c per gal.
Cost of machinery per horsepower	$100 (£20½)	$50 (£10¼)
Weight per horsepower.........	450 lbs.	100 lbs.
Fuel per horsepower-hour.......	1.3 lbs.	⅛ U. S. gal.
Cost of same....................	42½c (21*d*)	63.8c (31*d*)
First cost: Hull................	$2,900 (£600)	$1,800 (£370)
Machinery..........	$7,500 (£1,540)	$3,750 (£770)
Total...............	$10,400(£2,140)	$5,550 (£1,140)
Labor, cost per hour...........	$1.20 (4/11)	$0.60 (2/5½)
Total cost of operation per hour..	$1.625 (6/8)	$1.238 (5/1)

THE BROTHER JONATHAN AT FULL SPEED.

The first cost and cost of operation of a gas and steam tug of the same power is approximately shown by the table.

It will be seen from the table that the first cost and cost of operation of a gas tug of small power is much less than that of a steam tug, even though the fuel cost in the former is higher, the cost of labor accounting for the difference. The steam tug requires a hull 50 feet long, 14 feet beam and 6 feet 6 inches draft.

MARINE ENGINE DESIGN.

BY EDWARD M. BRAGG, S. B.

Calculations for the Connecting Rod.

Let $l = 2.25 \times \text{stroke} = 2.25 \times 42'' = 94.5''$

$k = 1.026;$

$P = 77{,}700 \times 1.026 = 79{,}800$ pounds;

$N = 12;$

$C = 70{,}000$ pounds;

$$f = \frac{70{,}000}{12} = 5{,}825 \text{ pounds.}$$

$$F = \frac{2 \times 79{,}800}{3.142 \times 5{,}825} = 8.73.$$

Formula (27):

$$D^2 = \sqrt{\frac{1.08 \times 8.73 \times 70{,}000 \times (94.5)^2}{10{,}000{,}000} + 76.2} + 8.73 = 34.53.$$

$D = 5.88''$, (Use 5⅞ inches), diameter at middle of rod.

Diameter at top of rod $= 5.875 \times 0.9 = 5.28$, (Use 5¼ inches);

Diameter at bottom of rod $= 5.875 \times 1.1 = 6.45$, (Use 6½ inches).

Load on bolts of crosshead pin caps $= \dfrac{79{,}800}{4} = 19{,}950$ pounds; this will require 2.5-inch bolts (see Table IV.).

$$T = 6.25'' + 2.5'' + 0.5'' = 9.25''.$$

Heads of bolts will be $1.5 \times 2.5'' = 3.75''$ diameter.

$9.25'' - 3.75'' = 5.5''$. The thickness Z of the fork can be 5⅜ inches and have the heads of the bolts clear the fork by $^1/_{16}$ inch. The length of the crosshead pin = 6.25 inches. Let the overhang of the box be ¾ inch on each side; $K = 6.25'' - 1.5'' = 4.75''$. We will make the caps of wrought steel.

Formula (29): $$S = \sqrt{\frac{79{,}800 \times 9.25}{2 \times 4.75 \times 7{,}500}} = 3.22'' \text{ (Use } 3\tfrac{1}{4}''\text{)}.$$

$F = 9.5'' + .25'' = 9.75'';$

$W = 9.75'' + 1.5'' = 11.25'';$

$V = 4.375'' + 4'' + 4'' = 12.375'';$

$Q = 2.5'' + .5'' = 3'';$

$N = 1.5''.$

The radius of the inside of the fork is $\dfrac{W}{2} = 5.625$ inches.

Draw lines parallel to XX, Figure 31, spaced 1 inch apart.

Formula (30): $$h^2 = \frac{3 \times 79{,}800 \times 1}{5.375 \times 5{,}000} = 8.92; \quad h = 2.985 \text{ inches.}$$

$h^2_2 = 2 \times 8.92 = 17.84; \quad h_2 = 4.23$ inches.

$h^2_3 = 3 \times 8.92 = 26.76; \quad h_3 = 5.18$ inches.

$h^2_4 = 4 \times 8.92 = 35.68; \quad h_4 = 5.97$ inches.

$h^2_5 = 5 \times 8.92 = 44.60; \quad h_5 = 6.68$ inches.

The dimensions of the collar nuts can be taken from Table V.; total thickness of liners for crosshead end to be 2 inches, as follows:

1 cast iron liner 1¾ inches thick,

1 brass liner ¼ inch thick.

1 tin liner	$^1/_{16}$ inch thick.
1 tin liner	$^1/_{32}$ inch thick.
2 tin liners	$^1/_{64}$ inch thick.

Each bolt of the crank pin box must carry $\frac{79{,}800}{2} = 39{,}900$ pounds.

From Table IV., the diameter should be $3\frac{1}{4}$ inches.

Formula 37 (see below under crank shafts) gives the size of the crank shaft.

$$D = (0.038 \times 23.5 + 0.009 \times 41 + 0.002 \times 64. + 0.0165 \times 42.) \times \sqrt[3]{185} = 11.9'', \text{ (Use 12 inches).}$$

Make the diameter of the crank pin $12\frac{1}{2}$ inches.

Formula (31): $L = 1.6 \times \frac{21{,}000 \times 1{,}000}{850} = 39{,}500$ pounds.

From Table VII., allowable pressure = 225 pounds. $\frac{39{,}500}{225} = 175.5$ square inches. Length C of crank pin $= \frac{175.5}{12.5} = 14$ inches. Let the box overhang 2 inches on each side; then $L = 10$ inches. $U = 12.5'' + 3.25'' + 0.75'' = 16.5''$. Make the cap of cast steel.

Formula (32): $R = \sqrt{\frac{79{,}800 \times 16.5}{10 \times 5{,}000}} = 5.12''$, (Use $5\frac{1}{4}$ inches).

Let $M = 2''$, $O = 0.625''$, $P = 3.75''$. Total thickness of liners for crank-pin end to be $3\frac{1}{4}$ inches, as follows:

1 cast iron liner	$2\frac{3}{4}$ inches thick.
1 brass liner	$^5/_{16}$ inch thick.
2 tin liners	$^1/_{16}$ inch thick.
1 tin liner	$^1/_{32}$ inch thick.
2 tin liners	$^1/_{64}$ inch thick.

SHAFTING.

Crank Shaft.—The stress upon the crank shaft can be figured by means of the formula $f = \frac{M\,y}{I}$,

where M = the maximum equivalent twisting moment;
y = radius of shaft;
and I = polar moment of inertia.

$$\text{or}\quad f = \frac{\frac{TD}{2}}{\frac{\pi D^4}{32}} = \frac{16T}{\pi D^3}.$$

For solid shafts,
$$D = \sqrt[3]{\frac{T \times 5.1}{f}}. \tag{33}$$

For hollow shafts,
$$f = \frac{T \times D \times 5.1}{D^4 - d^4}. \tag{34}$$

The maximum twisting moment can be obtained from the mean twisting moment by means of a factor derived from analyses of engine trials. The mean twisting moment

$$= \frac{I.H.P. \times 33{,}000}{2\pi n}, \tag{35}$$

where $I.H.P.$ = total indicated horsepower of engine,
and n = revolutions of engine per minute.

The maximum can be obtained from this by multiplying by a factor C, which has the following values:

Single-cylinder engine,	$C = 2.$
Two-cylinder engine,	$C = 1.5$
Three-cylinder engine,	$C = 1.33$
Four-cylinder engine,	$C = 1.25$

The crank shaft is subjected to bending as well as twisting, and the equivalent twisting moment is usually found by use of the formula:

$$T_1 = M + \sqrt{M^2 + T^2}, \tag{36}$$

where M = the bending moment at the section where
T = the maximum twisting moment.

The load upon the crank shaft is intermittent in character, varying from a maximum to a minimum. The factor of safety to be used, then, is 8 if the twisting moment is that given by formula (36). If the bending moment is neglected, and only the twisting moment is used in figuring the shaft, the factor of safety should be increased to 10.

In order to get a rating it is necessary that not only a ship's hull but also certain parts of its machinery shall conform to the rules of the registering society. The crank shaft is one of the parts of machinery whose size is specified, so that its diameter will be determined by some of the following rules, rather than by the preceding formulæ.

Lloyd's Rules (1906-1907).—Stroke greater than ½ low-pressure diameter and less than low-pressure diameter.

Three Cranks at Equal Angles.—Ratio of low-pressure area to high-pressure area not over 9:

Diameter of line shaft

$$= (0.038A + 0.009B + 0.002D + 0.0165S) \times \sqrt[3]{P}. \tag{37}$$

Four Cranks at Equal Angles.—Ratio of low-pressure area to high-pressure area not over 12:

Diameter of line shaft

$$= (0.033A + 0.01B + 0.004C + 0.0013D + 0.0155S) \times \sqrt[3]{P}. \tag{38}$$

Diameter of crank shaft = 21/20 diameter of line shaft.

Diameter of thrust shaft between collars = 21/20 diameter of line shaft.

Diameter of screw shaft

$$= \left(0.63 + \frac{0.03P}{T}\right) \times T,$$

where P = diameter of propeller, and T = diameter of line shaft. In no case must the diameter of screw shaft be less than $1.07\,T$.

In the above,

A = diameter of high-pressure cylinder in inches;
B = diameter of first medium-pressure cylinder in inches;
C = diameter of second medium-pressure cylinder in inches;
D = diameter of low-pressure cylinder in inches;
S = stroke of engine in inches;
P = gage boiler pressure.

Bureau Veritas Rules (1907) for shafting of double, triple and quadruple expansion engines, no overhung cranks:

$$d = \sqrt[3]{\frac{PL(n_1 D_1^2 + 0.1nD^2)}{C}}, \tag{39}$$

where d = diameter of after shaft bearing in inches;
n_1 = number of high-pressure cylinders;
D_1 = diameter of each high-pressure cylinder in inches;
n = number of low-pressure cylinders.
D = diameter of each low-pressure cylinder in inches.
L = length of stroke, in inches, common to all pistons.
P = gage boiler pressure in pounds per square inch.

For hollow shafts the diameter must be increased by 1 percent if the diameter of the hole is 0.4 of the outside diameter; by 2 percent if the diameter of the hole is 0.5 of the outside diameter; by 5 percent if the diameter of the hole is 0.6 of the outside diameter, and by 10 percent if the diameter of the hole is 0.7 of the outside diameter.

If the sequence of cylinders and angles of the cranks in quadruples are so chosen as to reduce the maximum torsional

Type of Engine.	No. of Cylinders.	No. of Cranks.	Angle Between Cranks.	Value of Factor C.
Compound.....	2	2	90°	3,400
Compound.....	4	2	90°	3,500
Compound.....	6	3	120°	3,800
Compound.....	2	1	....	2,100*
Compound.....	3	3	120°	3,600
Triple.........	3	3	120°	3,900
Triple.........	3	2	90°	3,000
Triple.........	4	2	90°	3,300
Quadruple.....	4	2	90°	3,100†
Quadruple.....	4	4	90°	4,000†

* Cutoff at 0.8 in high-pressure cylinder.
† Subject to approval.

moment the above values may be increased, but in no case shall they exceed 4,100. Each particular case must be submitted for approval.

The diameter of propeller shaft must be $\left(1.7 \dfrac{D}{d} - 15\right)$ percent in excess of the diameter of the crank shaft; where D = diameter of propeller in inches, and d the diameter of crank shaft in inches. The diameter of thrust shaft at the bottom of collars, both between and immediately beyond these latter, to be equal to that of the crank shaft, and tapered off at each end to the smaller diameter of the body of the shaft. For tunnel shafts, a reduction of 6 percent on the diameter of the crank shaft will be allowed.

Turbine Shafting.—In turbine engines, where $I.\,H.\,P.$ is the estimated power transmitted by each shaft,

$$d = \sqrt[3]{\frac{70 \times I.\,H.\,P.}{R}};\quad d_1 = d + \frac{D}{160};\quad d_2 = 1.05d, \qquad (40)$$

where d = diameter of tunnel shafting in inches;
d_1 = diameter of propeller shaft in inches;
d_2 = diameter of rotor shaft in inches at smaller part;
D = diameter of propeller in inches;
and R = number of revolutions per minute.

American Bureau of Shipping Rules for Shafting.

$$S = \sqrt[3]{\frac{PD^2L}{K\left[\dfrac{D^2}{d^2} + 2.4\right]}}, \qquad (41)$$

where S = diameter of crank shaft in inches;
P = gage pressure at boiler in pounds per square inch;
D = diameter of low-pressure cylinder in inches (if there is more than one low-pressure cylinder, then for D^2 use the sum of the squares of the diameters);
L = length of stroke in inches;
K = factor from following table:

Type of Engine.	No. of Cranks.	Angle Between Cranks.	Value of Factor K.
Compound...............	2	90°	1,450
Compound...............	2	180° or 0°	1,200
Compound (3 cylinders)...	3	120°	1,500
Triple...................	3	120°	1,700
Triple (4 cylinders).......	4	90°	1,600
Quadruple...............	4	90°	1,800
Quadruple (5 cylinders)....	5	72°	2,100

In four-crank engines with unequal spacing of cranks, K must be decreased as follows:

If smallest angle lies between 75 degrees and 85 degrees, decrease K by 100; if smallest angle lies between 65 degrees and 75 degrees, decrease K by 200; if smallest angle lies between 55 degrees and 65 degrees, decrease K by 300.

For hollow shafting see under equation 39. The diameter of the propeller shaft is to be 6 percent in excess of the diameter of the crank shaft. The diameter of the tunnel shafting may be 5 percent less than that of the crank shaft.

Crank shafts are generally made in sections, one section for each cylinder. The sections are flanged and joined together by coupling bolts. Shafts may be divided into two classes, forged and built-up, and still further divided into solid shafts and hollow shafts. In the merchant marine, shafts less than 12 inches diameter are usually forged, as shown in Fig. 32, except that they are seldom hollow; above that diameter they are usually built up, as shown by Fig. 33. Hollow shafts are seldom used in merchant ships, but are used almost altogether in vessels of the navy.

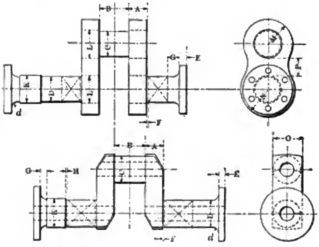


FIG. 32.—(BOTTOM). FIG. 33.—(TOP).

The proportions of the different parts should be as follows:

Diameter = D (see above).
Thickness of webs = A = 0.6D to 0.7D.
Length of crank pin = B = length of crank pin box + ⅛ inch to ⅜ inch.
Diameter of crank pin = C = D to D + 1 inch.
Thickness of couplings = E = 0.22D to 0.25D, naval engines.
= 0.25D to 0.28D, merchant engines.
Clearance between webs and main bearings = F = ¼ inch to ⅜ inch.
Clearance between couplings and main bearings = G = 2 inches to 3 inches.
Clearance between eccentric pads and main bearings = H = ¼ inch to ½ inch (minimum).
Radius of coupling fillet = d = 1 inch to 2 inches.
Diameter of eccentric pads = K = D + ½ inch to D + ¾ inch.
Diameter of journal and pin in crank webs = L = C + ½ inch to C + 1 inch.
Radius of crank web at pin = M = 0.875L.
Radius of crank web at shaft = N = 0.925L.
Breadth of web in solid shafts = O = 1.05D to 1.1D.
Metal between shaft and pin = P = 0.45L (at least).

When the three sections of shafting for a triple engine are to be interchangeable, all of the crank webs should be of the same thickness, otherwise the forward webs can be made thinner than the after webs, having a thickness of 0.6 D at the forward end and 0.7 D at the after end. The bearings can be of different lengths, but sufficient clear space must be

allowed on all sections of the shaft to accommodate the longest bearing, if the sections are to be interchangeable.

The diameter of the coupling flange must be determined by the size of the coupling bolts used. The pitch circle of the bolts must be large enough to permit the nuts on the ends of the bolts to turn, without having to cut away anything but the fillet of the flange. The correct number of bolts and diameter of pitch circle can be determined only by trial. In the first assumption, the radius of pitch circle can be taken as 0.75 of the diameter of the shaft, and in the largest sizes of shafts one bolt is allowed for about each 2 inches of diameter of shaft. In order that the shearing strength of the bolts may equal the torsional strength of the shaft, the diameter of the coupling bolt should be, for solid shafts,

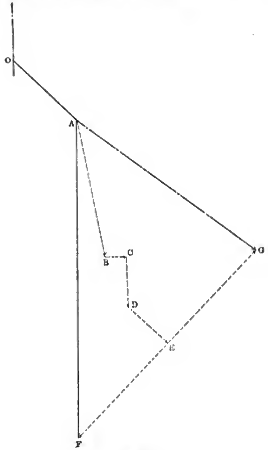


FIG. 34.

$$R = \frac{D}{2} \times \sqrt{\frac{D}{n \times r}}, \qquad (42)$$

and for hollow shafts:

$$R = \tfrac{1}{2}\sqrt{\frac{D^4 - d^4}{D \times n \times r}}, \qquad (43)$$

where R = diameter of coupling bolt at shearing section;
D = outer diameter of crank shaft;
d = inner diameter of hollow shaft;
n = number of coupling bolts;
and r = radius of pitch circle of coupling bolts.

The diameter of the coupling flange should be $2(r + R)$.

The coupling bolts are usually tapered from end to end at the rate of 1 inch per foot. Where the nut is attached at the smaller end the diameter of the bolt can be reduced from ¼ inch to ½ inch, as the nut serves merely to keep the bolt in place.

BEARINGS.

The diameter of the crank shaft in the main bearings is that given by the formula for crank shafts. The length of the bearings is made such that the bearing pressure shall not exceed that given in Table VII. The loads upon the bearings increase as we go towards the propeller, and are not all of the same character. In some cases the bearing pressure is well distributed over the entire circumference of the bearing; in other cases it tends to act upon a small portion only. As the important thing about a bearing is that it shall be sufficiently large to be kept cool, it can be seen that a larger unit bearing pressure can be allowed where the load is well distributed than where it is concentrated upon one part only.

When a piece of shafting, such as a line shaft, for instance, is transmitting power, there is no load upon the supports except that due to the weight of the shafting. If, however, a crank is introduced into the shaft, and a bearing placed on either side of the crank, these bearings will be subjected to loads in addition to those from weight alone. The force which one web delivers through the crank pin to the other web will be felt upon the bearing adjacent to the latter web, while the reaction which the first web experiences will be felt upon the bearing nearest that web. These loads upon the bearings must be equal in amount and opposite in direction, in order that the shaft which was in equilibrium before the crank was introduced may still be in equilibrium.

The turning force acting at the crank pin will increase as we go towards the propeller, so that this component of the bearing pressure will become more predominant. The components of the bearing pressure are shown in Fig. 34. OA is the position of the crank after it has turned through 135 degrees. AB is the force acting through the connecting rod, and is composed of the weight of the reciprocating parts and the unbalanced steam pressure on the piston. BC is the crossthrow of the connecting rod. CD is the resultant of the weight of the shaft and the inertia of the reciprocating parts. DE is the centrifugal force of the unbalanced parts of the crank webs and crank pin. EF is the force acting upon the after web, due to the turning force from the forward cylinders. EG is the reaction upon the forward web, due to the above force. AF is the resultant force acting upon the after bearing, and AG is the resultant for the forward bearing.

It will be seen that, if the turning force were left out, as is the case in the bearings of the first cylinder, the two bearings would have the same load upon them, and acting in the same direction. The effect of the turning force, however, is to cause the resultant loads to differ quite widely in amount and in direction. As the turning force changes its direction of action through 360 degrees during a revolution, its effect upon the resultant, as it becomes more predominant in the bearings nearer the propeller, is to cause the load to be distributed more uniformly around the bearing. In the case of the forward bearing of each pair of bearings, since the reaction of the turning force is, in general, acting in a direction opposite to that of the other forces, the resultant tends to act upon the sides of the bearings.

The mean load upon the bearings can be found approximately by means of the formula:

$$L = \frac{21{,}000}{PS}(HP_1 + fHP_2), \qquad (44)$$

where PS = piston speed in feet per minute;
HP_1 = the indicated horsepower developed by the cylinders forward of the cylinder whose bearings are in question;
HP_2 = the indicated horsepower developed in the cylinder over the bearings;
and f = a factor whose value can be taken from the curves given in Figure 35.

The factor f allows for two components of the bearing load, one due to the power being developed in the cylinder over the bearings, and the other due to the centrifugal force of the rotating parts. If we had to deal with the first component only, f would be constant for all horsepowers, but since the centrifugal force of the rotating parts increases at a greater rate than the horsepower, the factor f will increase as the horsepower increases. When the centrifugal force of the rotary parts is balanced by weights upon the crank webs, the factor f will be taken as for zero *I. H. P.*

Sometimes the bearings between two cylinders are combined into a common bearing. In this case the load coming upon it

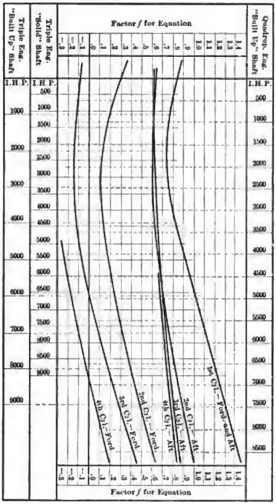


FIG. 35.

can be found approximately by calculating the load coming upon each bearing by means of formula 44, and multiplying the sum of the two loads by a factor taken from the following table:

TABLE OF FACTORS FOR COMMON BEARINGS.

Between.	Type of Engine.	Angle Between Cranks.	Factor.
1st and 2d cylinders..	Triple; high leading....	120°	0.6
	Quadruple............	180°	0.45
	Triple; low leading.....	240°	0.85
2d and 3d cylinders..	Quadruple............	90°	0.47
	Triple; high leading....	120°	0.625
	Triple; low leading.....	240°	0.9
3d and 4th cylinders..	Quadruple............	180°	0.875

When two cranks are at 180 degrees from one another, with a common bearing between them, the steam loads are opposed to one another, and balance, if equal powers are developed in the two cylinders. On the other hand, the loads from the turning force, being transmitted through the crank pins, are added to one another. This can be readily seen when it is remembered that the common bearing serves as the after bearing of one cylinder, and the forward bearing of the other cylinder. Since the cranks make an angle of 180 degrees, the two forces, which in the bearings for a single crank are opposed to one another, are in this case added to one another.

It will be found usually that in the case of triple-expansion engines the two bearings of the first cylinder and the forward bearing of the second cylinder can be made of the same size, also that the after bearing of the second cylinder and the forward bearing of the third cylinder can be made the same. The after bearing of the third cylinder will be the largest of all.

(To be Continued.)

BOW WAVE THROWN UP BY THE CRUISER MONTANA AT FULL SPEED.

Bow Wave of the Montana.

When the American armored cruiser *Montana* passed through her official trial trip last spring, and attained a mean speed for four hours of 22.26 knots with 27,489 indicated horsepower, a photograph was made of the bow wave when running full speed. This photograph was taken from the extreme port end of the flying bridge, and is here reproduced.

The *Montana* is a large armored cruiser, having a displacement of 14,500 tons at her normal draft of 25 feet. The length is 502 feet on the waterline, with an extreme beam of 72 feet 8 inches. The ship at this draft carries 900 tons of coal, but has stowage capacity for no less than 2,000 tons. The main battery includes four 10-inch rifles mounted in pairs in two turrets on the center line, forward and aft, and sixteen 6-inch rapid-fire guns, located twelve on the gun deck and four on the main deck. The secondary battery includes twenty-two 3-inch and twelve 3-pounder rapid-fire guns, six

machine guns and four 1-pounder automatic guns. There are four submerged torpedo tubes. The armor includes a belt 16 feet wide and 5 inches thick (3 inches at ends). The turrets and barbettes have, respectively, 9 and 7 inches of armor, maximum, while the guns in battery are protected by 5 inches. The armored deck varies from 1½ to 3 inches in thickness.

MARINE GASOLINE ENGINE DESIGN.

BY E. W. ROBERTS, M. E.

The object of this article is not to enter into all the lengthy details of gas-engine design, but to point out some special requirements for designing marine gasoline (petrol) engines according to modern ideas. With the exception of engines built to meet extreme racing requirements, lightness in pounds per horsepower, while desirable, is not the chief requisite. One should have, in a first class marine engine, strength, lack of vibration, stability, large wearing surfaces and certain lubrication as the major requirements to be met, and quite a number of minor requirements, that will be taken up during this discussion.

Strength, stability and lack of vibration practically go hand-in-hand. An engine lacking either one of these is a very poor engine for a boat, and will give endless trouble. While strength and lack of vibration are not obtained by the same methods, yet, to have good stability, an engine must be both strong and vibrationless.

There is an inclination among designers toward extremely light engines, especially in those of the "built-up" type, to sacrifice strength in order to get extreme light weight. This

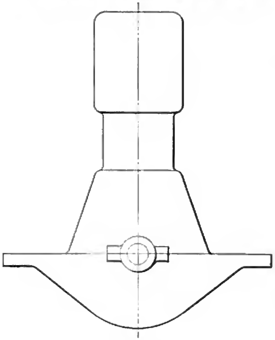


FIG. 1.

style of engine always reminds the writer of a little steam engine in one of his early boats, which was so flimsy that it had to be held when it got up to speed. The best style of frame for a four-cycle engine is what is known as an A-frame, and is of the general design shown in Fig. 1. This style gives strength without excessive weight, and has no chance to work loose from the motion of the engine.

Usually, for stability of operation, one of the chief requirements is a broad and long base for the engine to rest upon. On the earlier engines there was used a narrow frame, which made the engine inclined to rock on its foundation. Modern engines have a base extending outward, so that the foundation timbers may be carried forward of the fly-wheel, as shown

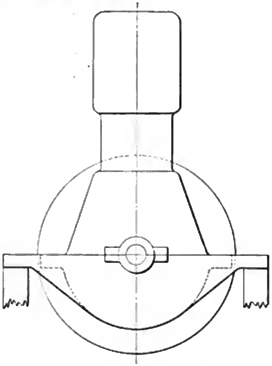


FIG. 2.

in Fig. 2 by the full lines. The old and the poorer way is shown by dotted lines.

Quite a number of marine engines are constructed with a flat bed-plate forming part of the base. In extending this to reach beyond the fly-wheel, it is likely to be made very heavy. This surplus weight can be avoided by using well-ribbed arms, instead of a plate. Quite a few boat-builders are inclined to think that this is detrimental to the working of the engine; but they will find, on inspection, that quite a number of automobile engines are built in this way. In large engines, with heavy fly-wheels, it is often necessary to make an extra broad arm near the fly-wheel, using, if the occasion requires, three ribs instead of two. Quite frequently it is of advantage to face the top of the foundation timbers with iron, in order that an arm may not be drawn too tightly into the foundation timber and, therefore, twist the base out of line.

The minimum of vibration is obtained in single-cylinder engines by careful counterbalancing. Generally this is done in a half-hearted way by guess, and no means are employed when the engine is being built for verifying the counterbalancing effect. Quite a number of builders are inclined to balance their single-cylinder engines in the fly-wheel. First-class results can be obtained only by counterbalancing with bob weights on the crankwebs. The best results, in a trunk piston engine, can be obtained by balancing with bob weights according to the following rule: Weigh carefully the piston with its piston pin and piston rings, and then weigh each end of the connecting-rod, by placing one end on the scale and balancing the other end on a knife edge, directly opposite the center of the bearing, and with the connecting-rod held horizontal. Then design a counter weight with a balancing effect equal to one-half the weight of the piston plus one-half the small end of the connecting-rod plus the whole weight of the large end of the connecting-rod and the crankpin, and with a lever arm equal to that of the crankpin. Add to this the leverage of the crankwebs, taken at the center of gravity. In other words,

balance half the reciprocating parts and all of the rotating parts.

Stated as a formula, it would be as follows:

Let P = weight of piston with pin and rings,
D = weight of piston end of rod,
C = weight of crank end of rod,
W = weight of web,
Q = weight of crankpin,
T = crank throw = one-half stroke,
S = radius to center of gravity of web,
R = radius to center of gravity of counterbalance, and
K = weight of counterbalance.

$$\text{Then } K = \frac{[\frac{1}{2}(P+D)+C+Q]\,T+W\,S}{R}$$

A bob weight may be cast from gray iron, with wrought iron straps cast on, as shown in Fig. 3, and the weight may be riveted to the crankwebs by means of these straps.

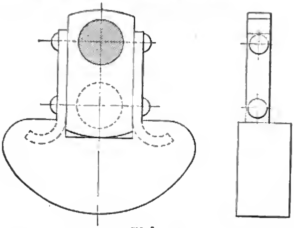


FIG. 3.

Finally, check up your balance weight, as shown in Fig. 4, laying the crankshaft on a pair of straight edges and hanging a weight W on the crankpin, as shown. As the crankpin and the crankwebs are used, the weight should equal $\frac{1}{2}(P+D)+C$. The weight may be added to by drilling with an under cut and filling with lead, and weight may be taken out by drilling. It takes but a moment to make this test, and it should be done with every engine, principally for the reason that blow holes may occur in the counterweight that would not otherwise be detected. When space is limited, as in the crankcase of a two-cycle engine, it is a very good scheme to core out the inner part of the weight and fill it with lead. The best method is to make the casting heavy and to drill the weights, to bring them to a balance.

In multiple-cylinder engines, other rules apply. Two-cylinder four-cycle engines are usually made with the cranks on the same side of the crankshaft, in order to make the impulses come evenly. Such engines must be balanced by counterweights in the same way as a single-cylinder engine. Three-cylinder engines of both the two-cycle and the four-cycle types are usually made with the cranks 120 degrees apart. Four-cylinder, two-cycle engines have the after cranks at 180 degrees from each other, and the forward cranks at 180 degrees from each other; but the two pairs are placed at 90 degrees. Hence, when the engine is running, there is an impulse for each one-quarter revolution. In the four-cylinder, four-cycle engine, the two center cranks are together, and the crank pins at the ends are at 180 degrees from those in the center. See Figs. 5 and 6.

With the exception of the two-cylinder, four-cycle engine with the cranks together, it is necessary that the pistons and connecting-rods should weigh very closely the same. The allowable variation should not be over ¼ ounce per pound. The crankshafts themselves should balance, and special attention should be given to the balancing of three-cylinder cranks, as this type is that most likely to be at fault.

It seems scarcely necessary to call attention to the balancing of the fly-wheel, but this is something often neglected, or done in a haphazard sort of way; and there is nothing that will make an engine vibrate more than a poorly balanced fly-wheel. As an example of what may be done in balancing, the writer has seen a four-cylinder, two-cycle engine running at 600 revolutions on which was standing on end a full-length pencil. This pencil was the ordinary Eagle diagraph, from which the eraser had been removed.

One of the greatest nuisances of the old-style marine engine is the hot exhaust pipe. Various methods have been employed to overcome this objectionable feature and so prevent the possibility of burns. These, the operator knows, are only too frequent. The first method adopted was to cover the pipe with asbestos, or other heat-insulating material. Then gradually it dawned upon several designers that it would be possible to water-jacket the exhaust. At first the idea was merely to decrease the noise of the exhaust, and the earlier plan was to allow a portion of the outlet water to enter the exhaust pipe near the engine. This helped in muffling the exhaust, but was of little service, so far as preventing burns was concerned. Then came the water-jacketed exhaust manifold, which in some cases is extended so that the entire exhaust pipe is jacketed to the outlet into the sea.

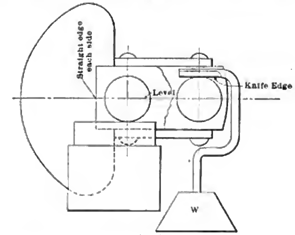


FIG. 4.

The water-jacketed exhaust is easier attached to the two-cylinder than the four-cylinder engine. In certain styles of four-cycles, however, the exhaust is carried down through a pocket in the water-jacket of the engine and is brought out near the base. A hot pipe near the floor is not so apt to be troublesome as one within easy reach. If the exhaust is jacketed where it leaves the engine, and the pipe lagged with non-conducting material from where it leaves the manifold, it will be found quite satisfactory.

The usual practice is to lead the circulating water into the top of the cylinder and out through the jacket of the exhaust manifold. The opposite plan appears to the writer the more rational. An engine will run best when it is warm. On the other hand, it is desirable to keep the exhaust as cool as possible, both to cool the exhaust gases and thereby contract them, and to make it possible to touch the manifold without discomfort. It will be found that the warmer the engine is run, the greater will be its efficiency.

The location of the carbureter should be low, in order to have a sufficient head of gasoline to make the fuel flow freely.

The rule, on the average engine, is to so place the carbureter that the level of the gasoline in the float chamber is not over 2 inches above the center of the shaft.

Starting the small marine engine is a simple matter, but with the larger bores the task becomes an irksome one. The starting crank, to be effective, must be very long or geared. A later method is to use a long bar carrying a pawl to engage a ratchet on the crankshaft. The engine is turned over until an explosion takes place, or until just over the center, and the ignition current turned on. The latter is the safest method, as then a back kick will not carry the lever with the engine. In any case, some safeguard should be used to prevent the lever from being thrown backward and injuring the operator or damaging the boat. One builder of large engines makes the ratchet of cast iron, with weak teeth, so that in case of a back kick the teeth are broken. Three or four spare ratchets are carried on board. A much simpler way is to make the pivot pin of the pawl just strong enough to pull the engine over. A sudden jerk will shear the pin and prevent damage. It is much cheaper and simpler to replace, and takes up less room than the ratchet. In fact, an ordinary wire nail will answer for the pin. In Britain, the starting lever is mounted on an A-frame, at an easy position for the operator. This method has not found favor in America.

For large engines, the more rational way of starting is by means of compressed air. In fact, when the horsepower runs into the hundreds it is by far the most practical. The simplest way to start on compressed air is to use some form of throttle valve, and to admit the air by hand at the proper time in the stroke. A later improvement is to employ an air valve operated from the cam shaft. The engine then operates as an air engine until the gasoline cycle is taken up. In order to get an impulse every revolution, the cams are so arranged that, in starting, the mixture inlet valve is closed, and the exhaust valve opens at each revolution. This is usually arranged so that, in a multiple-cylinder engine, one cylinder is running on air while the others are taking up the gasoline cycle.

The latest and the best method, from the practical standpoint, of operating large engines is to so construct the engine that it can be run either ahead or astern by shifting the cams. The air-starting mechanism is arranged to work in both directions, and the engine can be handled very much like a steam engine. The mechanism used to operate an engine ahead or astern is very complicated for a four-cycle engine, and is hardly worth while on engines under 100 horsepower. For the smaller engine, reversing propellers and reversing gears are used, with the latter somewhat in better favor. A few two-cycle engines are arranged to reverse by means of the ignition. This is quite satisfactory for small craft, provided the reversing mechanism is made automatic and controlled by a governor.

The growing favor of the two-cycle motor, especially for the smaller craft, calls for a few remarks on the design of this class of motor. For many years we have been accustomed to the old two-port type, in which the suction of the charge into the crank case is through a check valve. For speeds below 600 revolutions per minute this type has been very satisfactory; but when running at higher speeds, the three-port type gives the best service. With the advent of the racing boat, growing more and more into favor each year, the demand was for comparatively light motors of the high-speed type. There at once came a protest from the builders of low-speed motors that good service, especially in the two-cycle, could not be obtained at high speed, and that the motor would be short-lived. The assertions they made were, however, based upon their trials with low-speed motors at high speed, and the fact was overlooked that we have had high-speed steam engines with us for a number of years, giving good service. Gasoline engines will stand up just as well when operated at high speeds as at low speeds, provided that they are correctly proportioned for the speed at which they are to be run.

The main points to consider, when designing an engine to run at high speed, are to make the reciprocating parts as light as possible without sacrificing strength, and to make the bearings of ample length. The crank pin, being the hardest to lubricate, should have particular attention. The designer is especially asked to note that it is the length, rather than the projected area, of the bearing surface that is important in the

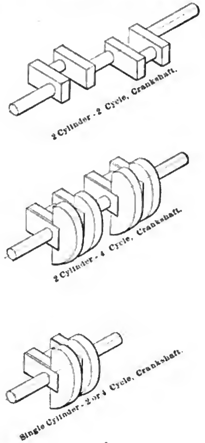


FIG. 5.

design of high-speed engines. In his *Manual of the Steam Engine*, the late Professor Thurston gives the following formula for the length of an engine bearing:

Let P = the total mean pressure = area $\times$ mean effective pressure,

R = revolutions per minute,

L = length of the bearing in inches.

$$\text{Then } L = \frac{P\,R}{600{,}000}$$

It has been found, however, in high-speed gasoline engines, especially where the lubrication was the least uncertain, that the formula given is very likely to cause trouble with hot crank pins. In recent designs a constant of 500,000 has been used for the denominator of the above fraction, and even as low as 400,000, where circumstances would allow. This extra length is especially desirable in high-speed, two-cycle motors, wherein the oil is swept from the base almost as fast as it enters. For example, the constant 500,000 gives for a 4-inch bore and a mean effective pressure of 80 pounds per square inch a length of 2 inches at 1,000 revolutions per minute. For a 4½-inch bore, the length of the pin should be 2½ inches.

In the length of the crankshaft bearing, the designer is

usually restricted by the length over all of the motor. The inner bearings between the cylinders should be approximately twice the diameter of the shaft, and the outer bearing at least two and one-half times the diameter of the shaft, especially in a high-speed, two-cycle motor.

The length of the piston pin can usually be made the same as that of the crank pin, and, in order to insure the minimum amount of wear, the pin should be fully this length, or at least as long as the piston will allow, when it has to be made shorter. It is necessary always to get a good bearing in the piston. This does not mean approval of fastening the pin in the rod and allowing it to turn in the piston, as it is preferable to place the bearing in the connecting-rod.

Short pistons in high-speed engines wear loose quickly and, when this happens, they are inclined to slap. Many designers, especially of automobile motors, turn their pistons small at the center and thus reduce the wearing surface, under the mistaken impression that in this way they reduce the wear. It is usually considered a well-established principle in design that, for the same conditions, the larger the bearing surface the longer the wear. The piston should be not less than one-third longer than the diameter of the cylinder.

High-speed, two-cycle motors, carefully designed, give astonishingly good results in power and speed. The power of a well-designed two-cycle, three-port engine will be 1.32 delivered horsepower for each 100 cubic inches of piston displacement per 100 revolutions per minute. The best record of a four-cycle motor is 0.98 horsepower, and a great many give only 0.88. It is reported that cases of both two-cycle and four-cycle motors would do better than this, but the information was not such that the accuracy of the figures could be guaranteed. The figure 0.98 for the four-cycle motor has been obtained both from large motors operating at moderate speed and from small motors operating at high speed. For instance, 15.4 horsepower has been obtained from an 8 by 10-inch cylinder at 330 revolutions per minute, and 12 horsepower from a 5½ by 6-inch cylinder at 900 revolutions. With a mechanical efficiency of 85 percent, this would mean a mean effective pressure of 89 pounds per square inch. With the two-cycle, the mean effective pressure by comparison is but 60 pounds, due principally to the fact that a considerable portion of the stroke is employed in emptying and recharging the cylinder.

For some time it has been the practice of builders of marine gasoline motors to rate them at about 75 percent of their actual power. This is confusing, and is apt to lead to many misunderstandings. Since a marine engine of this type is nearly always run at its full power, there is no good reason why it should not be so rated. Therefore, a 5½ by 6-inch, four-cylinder, four-cycle should be rated at 48 horsepower, if designed for a high-speed motor, and proportioned according to the speed at which the motor is to be run. This size, properly designed, can be depended on for 48 horsepower at 900 revolutions.

The speed at which a marine motor should be run depends somewhat upon the boat and the class of water. Speed boats pure and simple need high-speed motors, and the higher the speed of the boat the higher should be the speed of the motor. This is for two reasons. First, in order to get the requisite power, without overloading the boat, a slow-speed motor may not be used. In speed boats, they being usually of shallow draft, the propeller should be of small diameter and comparatively low pitch. In order to get a high speed with a small pitch, the speed of the propeller must, of course, be high.

In slower boats it is comparatively easy to operate with a high-speed motor using a propeller of small diameter and pitch, provided that the boat does not have to buck into extremely heavy weather. Small wheels, however, have not the area to thrust against heavy resistance.

There is a great deal in the choice of a propeller wheel suitable for not only the engine, but the boat as well, and it is a good thing for the designer to have reliable data at hand on this matter. For example, identical engines will turn a certain wheel not over 800 revolutions per minute in a family launch, and in a racer will drive it up to 1,100 revolutions. The propeller for a speed boat should be most carefully balanced, otherwise it will not only cause the engine to vibrate, but it will reduce its speed. Ordinarily, the three-bladed

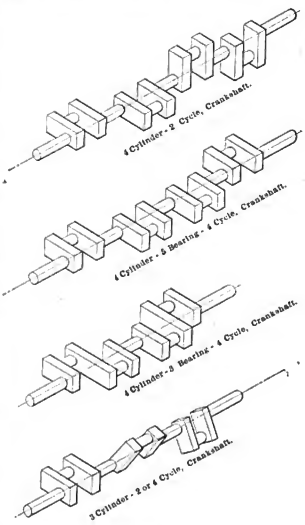


FIG. 6.

propeller has been found to be better balanced than the two-bladed. Two propellers have been taken, one a two-bladed and the other a three-bladed, both alike in diameter and pitch, and tested with the same boat and the same motor. With the three-bladed, the engine ran 720 revolutions per minute, and with but little vibration; while with the two-bladed, the engine slowed down to 650 revolutions, and the vibration was so great that the power had to be shut off.

Not being a propeller expert, the above experience with the two and the three-bladed screws is given for what it is worth. The propellers were furnished by a propeller specialist, and his word was taken that they were carefully balanced. Yet other propeller makers state that it is possible to make a two-bladed screw that will run as well at high speeds as one with three blades.

The Russian Cruiser-Battleship Rurik.

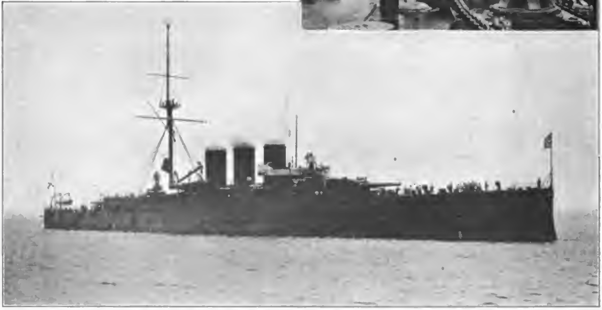
BY BENJAMIN TAYLOR.

We present a final photograph of the Russian cruiser-battleship *Rurik*, taken during her last series of steam trials on the Clyde, on the completion of which she was handed over to the Russian government—a completed bargain. We also give a deck view, taken from the bow of the ship, showing barbette, etc.

The speed trials were made in several runs over the measured mile at Skelmorlie, Clyde. The condition was that the engines should keep up an average number of revolutions equaling or exceeding the number corresponding to 21 knots, as ascertained on the measured mile trials. This was easily accomplished. The *Rurik* also carried through two 30-hour trials, one at about 19 knots and the other at about 12 knots. These trials were to determine the radius of action.

The mean of 10 hours at full power during 24 hours' trial was: Steam pressure, 280 pounds per square inch; vacuum, 26.2 inches; revolutions, 141.6 per minute; indicated horsepower, 20,675. All her twenty-eight (Belleville) boilers were in use, and the air pressure in the stokehold averaged 0.36 inch. The guaranteed horsepower was 19,700, and the revolutions required were 135 for 21 knots, so the results exceed the contract; the speed maintained having been approximately 22 knots. The heating surface is over 55,000 square feet, under easy steaming, is 20,000 indicated horsepower, with the boilers working at a steam pressure of 285 pounds to the square inch, reduced to 250 pounds before entering the engines. A complete system of auxiliary machinery has been fitted, and the pumping and drainage arrangements are the outcome of Russian Admiralty plans.

In respect to her armament, the *Rurik* is remarkable because, though called an armored cruiser, she has all the fighting power of a battleship. She is also specially equipped for repelling torpedo-boat attacks. All her guns have, possibly, a greater elevation and depression than in other ships. She has four 10-inch breechloading guns, 50 calibers in length, twin mounted in barbettes forward and aft on the center line, and each of them can be worked through 35 degrees of elevation and 5 degrees of depression. The forward guns can be trained 45 degrees abaft the beam, and the after guns 45 degrees before the beam. She has also eight 8-inch breechloading guns, 50 calibers in length, twin mounted in barbettes on the quarters of the ship. All these guns are electrically worked.



THE RUSSIAN CRUISER-BATTLESHIP RURIK.

VIEW FROM FORECASTLE LOOKING AFT.

Tests were also made of coal and water consumption, and as to an important condition in the contract with reference to stability. The temperatures were tested in various parts of the ship, etc., and maneuvering trials were carried out satisfactorily.

The *Rurik* was designed for a displacement of 15,200 tons on a draft of 26 feet, and is well within these limits. Her length between perpendiculars and on waterline is 490 feet, and the molded breadth is 75 feet. On normal displacement she carries 1,200 tons of coal, which may be increased to 2,000 tons by filling the bunkers. With the latter quantity, the estimated steaming radius at 10 knots is 8,000 nautical miles.

The machinery has been designed less for economy of weight than reliability. Her boilers are fitted for consuming coal or oil fuel. The propelling machinery consists of two sets of four-cylinder triple-expansion engines. The power,

For repelling torpedo attack there are twenty 4.7-inch quick-firing guns of 50 calibers in length; sixteen of these are in an armored battery in the center of the ship, separated from each other by transverses of specially hardened armor. This battery enables the secondary armament to be placed higher above the waterline than usual. It incidentally adds largely to the armored protection, as it is above the normal armored

side of similar ships. There are four 4.7-inch guns aft, also within armor on the sides of the ship. To counteract the effects of raking fire, three armored bulkheads have been fitted. There are twelve smaller quick-firing guns. Two 18-inch torpedo tubes, completely submerged, are placed forward.

On the gun trials 100 rounds of ammunition were fired from one of each type of gun. Thirty rounds were fired from two of the 10-inch guns and two of the 8-inch guns, and fifteen from the other guns, at various angles of elevation and depression and on various bearings. The gun mountings were worked to give a rapidity of two rounds per minute from the 10-inch guns, three rounds from the 8-inch guns, and eight rounds from the 4.7-inch guns. The 47-millimeter (3-pounder) guns were fired at the rate of between twenty and thirty rounds, and the Maxim guns at about 500 rounds per minute.

The *Rurik* has a complete armor belt from end to end and to a considerable distance below the waterline. It is 6 inches in thickness, tapering to 4 inches (Bow) and 3 inches (stern) at the extreme ends of the hull. This belt is 12 feet deep, and the thick portion amidships extends over a length of 270 feet. For protecting the 4.7-inch guns, the upper strake, for 200 feet of the length of the ship, is 3 inches specially hardened armor. The barbettes within this central battery are of much heavier armor, having 7¼-inch walls. The conning towers are of 8-inch armor. Two range-finding towers extend a considerable height above the upper deck, and are constructed of 5-inch armor. Protective decks of a combined thickness of 4 inches are arranged, to insure that high explosive shells shall burst outside the vitals of the ship. The base of each of the three funnels is protected by armored casings. The whole of the machinery and magazines are, under the waterline, surrounded by armored walls extending from the main deck, through the protective deck, to the bottom of the ship.

The *Rurik* was built, engined and armored by the Vickers Sons & Maxim Company, Barrow-in-Furness, having been launched Nov. 17, 1906.

The Russian papers have been severely criticising the construction of the ship, asserting that during recent firing tests on board, conducted by a special commission, four out of the eight 8-inch guns constituting part of the main battery were rendered unserviceable by the sinking of the turret foundations. It is declared that the cruiser will be valueless as a fighting unit until the turrets are rebuilt. The English constructors of the vessel attribute this to the faulty designs furnished by the Russian Technical Committee, while the Admiralty blames the builders.

A comparative table is given of the latest ships of this general character belonging to the seven leading naval powers. The only broadside greater than the *Rurik's* is that of the (battleship) *Kurama*. The propulsive results on the *Rurik*, as shown by the Admiralty coefficient, are remarkably fine; while the French and German designs show poor results.

	Russian, *Rurik.*	British, *Minotaur.*	American, *Montana.*	French *Rousseau.*	Italian, *Napoli.*	German, *Blucher.*	Japanese, †*Kurama.*
Displacement..	15,200	14,600	14,500	13,644	12,426	14,760	14,636
Horsepower....	20,675	27,856	27,489	*37,000	*23,000	*35,000	*22,000
Speed, knots ..	22	23.01	22.26	*23	*22	*23	*21.25
Admiralty coef.	316	261	239	188	248	209	261
Length, feet...	490	520	502	515	470	499	450
Battery.....	4—10"	4—9.2"	4—10"	14—7.6"	2—12"	12—8.2"	4—12"
	8—8"	10—7.5"	16—6"	....	12—8"	8—5.9"	8—8"
	20—4.7"	....	22—3"	....	12—3"	20—3.4"	14—4.7"
Broadside, lbs.	3,450	2,520	2,954	1,665	3,032	2,532	4,715

* Estimated. † Really a battleship.

THE SEA-GOING TUG DARENT, BUILT BY FERGUSON BROTHERS, PORT GLASGOW.

A New Thames Tug-Boat.

The powerful screw tug *Darent*, built by Ferguson Brothers, Port Glasgow, to the order of the Thames Conservators, carried out her speed trials on the measured mile, the mean speed of six consecutive runs being 11¾ knots, considerably in excess of the contract, and highly satisfactory.

The vessel is intended for general harbor service and to act as a tender to the conservancy dredging fleet. The officers' and crew's quarters are arranged aft of the machinery space, and are spacious and well equipped. The saloon forward is paneled in polished oak, the pantry and lavatories being tiled on floor and walls. A roomy chart house is fitted under the bridge deck.

Davis steam steering gear is fitted on bridge, also Chadburn's telegraph, with speaking tube and telephones to various parts of the vessel. Electric light by Clarke, Chapman & Company is fitted throughout, with powerful cluster lights for salvage work. The forward windlass is of Harfield's make.

The propelling engine is of the triple-expansion type, fitted with Brown's patent reversing gear, Axiom lubrication and United States metallic packing. Steam is supplied by a large multitubular boiler having a working pressure of 180 pounds per square inch.

The following auxiliaries are fitted in engine room: one

powerful fire and salvage pump, with swivelling monitor on deck. Caird & Raynor's evaporator, Railton & Campbell's feed filter, automatic float tank, feed pump, electric generator with direct-acting engine, and a fresh-water duplex pump. Fresh-water compartments are arranged in the vessel for supplying the dredgers, barges, etc., on the Thames.

Throttle Watch in a Typhoon.

BY S. F. SMITH.

A few days after target practice, on a hazy, hot, tropical morning, in Manila Bay, the word was passed by the boatswain's mate. "All hands up anchor!" The windlass rattled, and the "pick" was soon at the hawse-pipe.

The navigating officer on the bridge gave orders to port the helm, and moved the pointers of the engine-room telegraph from "stop" to "slow ahead" on starboard; to "slow astern" on the port. The 13,000-ton battleship trembled slightly from the motion of her engines, and began to swing slowly and majestically around to port, pointing her bow towards Corregidor Island, bound for Hong Kong, where we were to go into the Kowloon dry-dock to be cleaned, painted and have our sea valves overhauled.

We passed the historic Corregidor, and steamed up along the western coast of Luzon at a 10-knot speed. The weather continued hot, and the sea was calm, just a light air from the south, directly astern, causing poor draft, and hot, hard work in the fire rooms, in order to keep up the prescribed 150 pounds of steam at the boilers. The thermometer in the fire rooms registered 168 degrees F., in the engine room 138 degrees F.

The firemen, between the acts of firing, slicing and pushing back, dove under the ventilators and mopped the streaming perspiration from their eyes. "Whew! She's hot." But there is not much time to think about it—the above-mentioned cycles come around too often. No, the "land-lubber" fireman couldn't live down there.

About four bells, or after the evening meal, the wind changed to the eastward, and a slow, drizzling rain started. Someone said the "glass" was falling rapidly, indicating "a night of it." The men began to array themselves in their oilskins and "sou'-westers," and collected in small groups to the lee of the forward 13-inch turrets, smoking their pipes and talking in low tones about the prospects of the coming night, and listening to the prophecies of the older tars, who had had various kinds of "runs" through these seas before.

It was now seven bells, and raining hard, and the wind was blowing in gusts, causing the ship to list over to port a few degrees. It also caused the men around decks to seek shelter of some kind. We were now leaving the northern end of Luzon, and every now and then Cape Bojedor light—which flashes every minute—could be seen a few points off our starboard quarter. We began to feel the heave of the ship more distinctly now, as we plowed out into the Yellow Sea.

My hammock was swung on the berth deck. On my way to it from the main deck I had to pass through the gun deck. On entering this, and looking around, I found a far different scene from that on the main deck; men and boys were lounging around on their ditty boxes, playing cards, reading, talking and laughing, and it soon made one forget the dark night and the storm brewing outside.

No sooner had I rolled into my hammock than the whistle of the boatswain sounded, and after it, "Relieve the wheel and lookout!" I settled myself comfortably for my four hours' sleep; eight bells strike, the whistle again and after it, "Turn in your hammocks and keep silence about the decks!" was the last I heard before going to dreamland.

The next thing I knew someone was shaking me, saying, "Roll out, there; fifteen minutes, roll out!" meaning that I had only fifteen minutes to "roll out," dress and relieve my man in the engine room. I was just begining to think he was never going to stop shaking me, but on looking around I found everything else was being shaken up, from the ship "wallowing into it," so I "rolled" and hastily got into my "watch clothes" —not one of the shining uniforms the uninitiated "land pikers" see us in on our trips ashore—but overalls and a sleeveless shirt and a pair of No. 8 regulation navy shoes, which I sorted out from a half dozen other pairs, all having slid down to leeward against the bulkhead. I also picked up my cap from among them, and, after adorning myself in these things, staggered out through the alleyways to the engine-room hatch.

Steadying myself on the hot hand-rails, I made my way down through the starboard battle hatch, over the top gratings, passed the high-pressure cylinder—which greeted me with the familiar sound of heavy breathing as the steam entered and exhausted from it—down the ladder to the lower or handling platform.

The telegraph pointer stood at "half speed ahead," and the engines were running to correspond. I made the usual rounds before relieving my man at the throttle, and then went up to him, saying, "How is she, Peters?"

"Oh, everything is all right; we have been running half speed about two hours; I guess she is pounding into it pretty hard up there; steam 125, revolutions 55." And he went up the ladder, seeming glad his four hours of nerve strain was over, and little thinking he would be turned out to the tune of "All hands save ship!" inside of two hours more.

I took my station at the various levers by which the speed of the 5,500-horsepower engine is controlled, counted the revolutions of the high-pressure crank, noted the readings of the steam, receivers and vacuum gages and the indicator on the bulkhead, which divides the port from the starboard engine room, and found my engine leading slightly, which was proper. The warrant machinist went from one engine room to the other, not saying a word; but by the expression of his face I knew all was well.

The ship was pitching heavily, causing the engines to race slightly when settling her stern into the trough of the sea. At these moments I choked her with the butterfly valve, and outside of that the regular engine-room routine was carried on for the rest of the hour.

At one in the morning (two bells) the telegraph jangled, and the pointer came to rest at "Slow ahead." I choked her down to 30 revolutions per minute, and slowed down the main air and circulating pumps, and notified the water tender to check firing. The ship was now laboring heavily, and great care was necessary in moving around on the slippery floor-plates, or the result would be serious.

Everything was again going smoothly after slowing down. The ship did not receive the hard shocks as before, but rolled and pitched more heavily; so it was only to hold on, keep ears and eyes open, and watch the rhythmic rise and fall of the cranks, with their occasional racing. As this became monotonous, I whistled to the fire room, asking the water tender if all were well out there. The answer came back, "All O. K. out here."

I then asked Wilson, in the port engine room, how things were over there. "Oh, it's just lovely over here; I'm hanging on with my teeth and hands. I guess this must be a typhoon, all right."

"I guess it is the"—whew! whiss! hiss! hiss-s-s! Water comes down the hatch and ventilators, striking the hot pipes and cylinders, partly turning to steam. I try to duck it, with poor success; the ship takes a heavy dive, everybody holds on, and looks at each other. More water comes down the ventilators; the telegraphs jangle briskly, and the pointer stops at "Very slow ahead." I choke her, and notice the electric lights are getting dim, with occasional "winks."

"What do you think is happening?" from the young messenger boy.

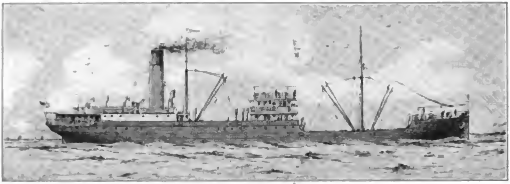
"I don't know, sonny," I answered, and told him to find a grease lamp and light it, but he seems so scared that he does not dare leave me. The lights now slowly die out entirely; something must be wrong with the dynamos. I told the oilers to light the bulkhead oil lamps with their hand lamps.

The water tender comes from the fire rooms. "Nos. 5 and 6 fire rooms are flooded! The coal has washed off the floor plates into the bilges and choked the strainers, and the pumps won't work on them!"

"Do the best you can to clear them, and get the pumps going light, and the ship laboring in the midst of a bad typhoon.

Try to imagine yourself in a corner of this room, hanging on with one hand and bailing water into buckets with the other; catching the water on the jump as it comes down towards you with the roll of the ship, dodging oil cans, waste cans, tools and no end of things that break loose in the excessive rolling. Oh, no! you don't have time to think of home and dry land, or if the ship is going down; things come too swiftly, and there are too many orders to execute.

The ship is now "hove to," and we ride it out. Two days later "Jack" is in the land of the Celestials, enjoying himself, and—never a typhoon.



THE STEAMER PARINGA, BUILT AT KINGHORN FOR AUSTRALIAN COASTING SERVICE.

on them." The warrant machinist goes with him to help keep the men in order.

A 'phone message from the bridge asks us how things are down here. We answer, "Our lights are out, the forward fire rooms are flooded, and the strainers choked with coal."

"Do the best you can," from the bridge. The chief engineer is down here now. He goes to the fire room, and comes back with the warrant machinist.

The engine cranks are now dipping into the water as it comes rushing in from the fire rooms, for the small bilge pump cannot handle it all; so we swing the main circulating pumps from the sea suction to the main drains.

I 'phone to the dynamo room, telling them our lights are out. "We are flooded up here; the water came down our ventilator and wet all our machines, so we had to shut down," comes the answer.

The word has long ago been passed on deck to "All hands save ship!" and bucket gangs are formed to clear the dynamo room and other compartments of water; some are at the hand pumps. The main drain strainers have choked with coal from the fire rooms, and we swing the main circulating pumps back on the sea suction, in order to cool our condenser, for the vacuum is falling.

We send men "diving" down to clear the strainers and try the pumps again, and so on for an hour or more, until we finally clear the bilges of water; then thoroughly clean out the coal and replace the floor plates. The forward fires are again worked, and general order is restored throughout the fire rooms and the engineering department in general.

It is now 3 o'clock, and we are still under "grease lights." I telephone to the dynamo room: "How soon can we have lights?"

"We don't know, as there is a great deal of water washing around the place yet."

My! but it must be nice up there; hot! whew! The dynamo room is situated directly over the boilers, and has only one 10-inch ventilator, through which they draw air with an electric suction blower, and that is now stopped on account of no "juice" from the dynamos, and only grease lamps for

An Australian Coasting Steamer.

The steamship *Paringa*, built by Messrs. Scott of Kinghorn, Ltd., was launched in April last for the Adelaide Steamship Company, of South Australia. The dimensions of the vessel are: Length between perpendiculars, 230 feet; breadth, molded, 36 feet; depth, molded, 16 feet 4 inches, with a gross tonnage of about 1,300. She has been built to the highest class with the British Corporation and to British Board of Trade requirements for a foreign-going passenger steamer.

This vessel has a long poop and forecastle, three cargo hatchways and five steam winches. Steam steering gear is placed aft in a steel house, and works direct on to the screw steering gear, which is of extra strong make, by Donkin & Company, Newcastle-on-Tyne. A large warping winch is also placed in this house.

The arrangement for working cargo is of the special design fitted on most of the Adelaide Company's vessels. A large casting is fixed to the deck, half-way between the center line and side of the ship. The goose neck for the derrick sits into a cast-steel nut, which can be moved by means of a square-thread screw. The head of each derrick is supported by chains to outriggers from the mast. The foot of the derrick can be moved in or out to suit loading or discharging cargo; and lifts are arranged for 10, 8 and 5 tons. There is also provision for fitting a 20-ton derrick.

Accommodation for twenty-eight first-class passengers is provided in two-berth rooms at the fore end of the poop on main deck. The rooms are tastefully fitted, and special attention has been made for keeping the rooms cool by means of large Boyle ventilators; each room is also provided with a goose-neck ventilator. These rooms are finished in white enamel and polished teak pilasters. The panels are polished jalousie, with expanded metal panels at top and bottom and an opening glass panel below the beams.

The dining saloon is in the deck house at fore end of poop. It is in polished hardwood, tastefully designed, with ceiling done in white and gold. Two electric fans keep this room cool. A smoke room is situated above, and is in polished hardwood, with ceiling of lincrusta, white and gold. An

electrically-operated fan is also provided for this room.

Accommodation is provided aft for sixteen second class passengers. The rooms are similar to the first class, jalousied and finished in white enamel. The captain and officers are berthed amidships on the lower bridge, while the engineers and petty officers are aft in sidehouses. The crew are forward in forecastle, and have their own bath room.

Special attention has been paid to all the accommodation, and all the rooms are large, airy and well ventilated, with everything that can add to the comfort of passengers and crew. Electric light has been fitted throughout the ship.

The engine, which is placed aft, is triple expansion, with a working pressure of 180 pounds per square inch. The cylinders are 21, 35 and two of 37 inches by 36-inch stroke. Two Babcock & Wilcox watertube boilers have been fitted. The grate area of the furnaces is 156 square feet, and the heating surface 5,000 square feet. A complete auxiliary outfit is provided, consisting of electric light plant, large ballast pump, sanitary pump and general steam pump.

The vessel was launched with steam up, and immediately proceeded to Burntisland under her own power.

Benjamin Taylor.

Trials of the Marine Contractor.

There was a busy atmosphere about the low-ceilinged office, with its corps of young men, each lending his share to a well-managed, energetic shipyard, the clicking of the typewriter following the earnest dictation (out of a cloud of cigar smoke) from the ever-busy manager, whose eyes gleamed at the prospective business this bid would bring, and the excitement that comes from honest competition to secure contracts from sealed bids. Most of us have felt the keenest nervous strain at one time or another in our lives, whether it has been with rod and reel, with the gun in a quiet valley, thick with undergrowth, out of which the gamest of birds start for liberty with a thrilling roar, or with other sports or anxious moments; but there is hardly a more anxious moment, when one's nerves are more highly strung, than that when the authority says: "Time is up; any more bids? Bids are closed." Then the opening.

A strange picture is presented at these openings. Seldom does the man whose money is at stake appear; more often one not so deeply interested represents the firm, and even among these men, of all ages and types, there is a grand opportunity for the study of face contortions. It is doubtful whether the actual contractor, having been through these exciting moments when he was assistant to another, could stand the strain of these ordeals, which are part of the daily business routine. They are usually well and gladly rid of the mission, but stand close by the 'phone at their offices awaiting the result, which their lieutenant hastens to transmit when all bids have been read and the successful bidder announced.

It was for a tremendous repair job to a large vessel, that all were anxious to get at a good price; but, work being scarce at the time, the chances for cut-throat prices were propitious, and generally understood to be likely. We visited the vessel, worked nights on the estimate, which was asked for to be in and opened three days hence. This, by the way, is customary—to have the contractors crowd a good week's work into this time or less, and necessitates a nerve-racking task, trying first one way and another to arrive at a fairly good price likely to secure the job, but still have a fair margin of profit, and name the fewest possible days that will complete the work, always having in mind a large demurrage payable for each and every day one fails to finish the work.

The bids opened, we were declared successful and the contract was awarded. A groan of relief arose from everybody, but a sigh of anxiety from the "boss." Immediately orders, right and left; things must be set in motion; no time to be wasted; minutes mean dollars from now on; a good figure for the job and a short period to finish; $300 per day demurrage for each and every day over contract time. Three hundred dollars bonus for each and every day contract completed previous to contract time. After the best part of contract time, all of which was spent in good, hard labor, the books show a good profit in sight—work well in hand—looks to be easily completed within the time and a few days' bonus in sight.

A snag is struck; needless to go into details; must be overcome, and means a vast amount of additional work. The foreman erred; the superintendent beside himself to get out with least possible loss of time and labor; estimated profit gone and demurrage seems inevitable. Owners of the vessel become anxious; have arranged sailing, and delay means more to them than amount of penalty to be suffered by contractor; day for completion rolls by and finish not in sight. The great blunder carries blame for every man connected with the plant, and when the ship finally steams away there's no thanks, but "hell to pay" for all hands.

Such is the life that may be understood only when directly connected with the concern handling such a character of work, and yet should you chance to be a visitor on one of the worst or most exciting days of these struggles, there is not the slightest surface disturbance evident; such strong, manly hearts and constitutions are meted out almost providentially to those to whom such cares and worries are no more than is expected. Smooth sailing comes more often than such trouble, but experience teaches that in the times of healthy prosperity perversity must play its part.

The Fire Float Beta.

In our September issue appeared photographs and a description of the pumps fitted to this vessel, which was specially designed by F. J. Trewent & Proctor, London, E. C., for this purpose. The hull was built of steel by Forrestt & Company, Wivenhoe, and is 100 feet 6 inches in length by 16 feet 6 inches molded beam, with a draft of 3 feet 6 inches—a specially light draft being necessary to enable the vessel to get as near to the shore as possible when attending fires. There are six watertight transverse bulkheads, which, in conjunction with fore-and-aft bulkheads on each side of the machinery and boiler space, render the craft practically unsinkable in the event of damage.

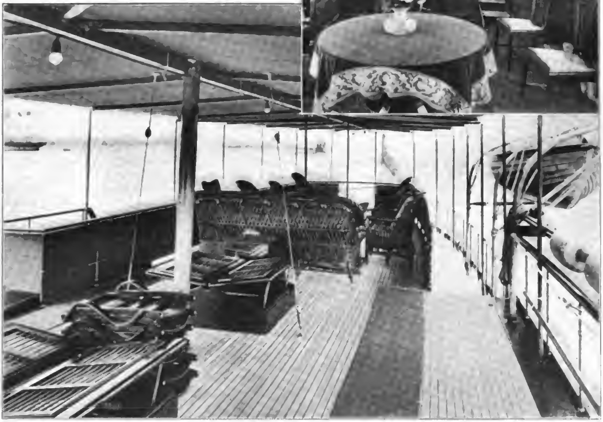
The twin-screw triple-expansion propelling engines and two watertube boilers, each fitted with an automatic feed regulating device, were manufactured by Mumford & Company, Colchester. The boiler room outfit includes a pair of powerful automatic feed pumps and general service pump, an evaporator for supplying fresh water to the boilers and a powerful forced draft fan. Each of the two boilers is capable of running the propelling machinery at full power. Steam is therefore always kept on one boiler, so that the vessel can be dispatched at a moment's notice. While on her way to any fire, the other boiler can be lighted up and be under full steam in a very short time, so that on reaching her destination both boilers would have a full pressure of steam for driving the pumps, both boilers being required to work the four pumps at their fullest capacity. The boiler room is arranged on the closed stokehold principle, and fitted with a powerful fan for forcing in air under pressure.

It is said that this vessel has the most powerful fire fighting installation of any afloat on such a light draft; and in designing her for this purpose it was found advisable to arrange the twin screws on the tunnel system, so as to obtain large enough propellers for the required speed. Suitable quarters are arranged for the crew aft, and she is lighted throughout with electric light.

A LARGE TWIN-SCREW MOTOR BOAT.

The *Cristina*, designed by Henry J. Gielow, New York, and built by George Lawley & Son, South Boston, for F. C. Fletcher, of Boston, is the largest of her type, and, having a hull of mild steel and scantlings a trifle heavier than the requirements of Lloyd's, she is fit for cruising anywhere. Her length over all is 110 feet; length on the waterline, 103 feet 5 inches; beam, molded, 17 feet 6 inches, and draft, 6 feet. The lines are fair and easy, running in an unbroken sweep from bow to stern. The sheer is sufficient to meet head seas without too much wetness. The deck is virtually flush, extending unbroken for a distance of 72 feet from the bow, where it drops 2 feet on each side for a width of 3 feet, leaving a central trunk extending 20 feet further aft. This arrangement affords excellent ventilation, and does away with the high appearance of many flush-decked motor boats. The only spar is a signal mast aft of the funnel. The latter is used for ventilating galley and engine room.

A deck house forward, 20 feet long and averaging 12 feet wide on the inside, is depressed 16 inches below the main deck. Up to the lower sides of the windows this house is



DINING SALOON AND DECK SPACE AFT ON STEEL TWIN SCREW MOTOR YACHT CRISTINA.

(Photographs, N. L. Stebbins, Boston.)

constructed of steel plating, and is finished with teak panel work both inside and outside. This deck house is fitted up as a dining room, using ordinary chairs, and a round extension table. Aft on the starboard side a stairway leading down to the staterooms and cabin is visible at the left of our illustration. On the port side steps lead to the main deck. Between the two stairways is a sideboard and buffet, finished in teak, with a small dumbwaiter leading to the galley immediately below.

The only other obstructions on the flush deck are two skylights aft of the funnel, and lighting, respectively, the saloon and the passage between staterooms, the companionway forward for the crew and a steering platform, 7 by 8 feet, located between the deck house and the funnel. This platform is inclosed with a brass railing and covered with an awning.

Below decks the forepeak is occupied by chains. Aft of the collision bulkhead is the forecastle, 14 feet in length, including the crew's toilet and locker rooms. Berths are here provided for four men. Staterooms for the captain and engineer, fitted with wardrobes, etc., come next. Then comes the engine room, 12 feet in length, immediately beneath the dining saloon. This room is inclosed in steel watertight bulkheads, with all woodwork fireproofed and covered with asbestos, in order to reduce to a minimum all danger from fire.

THE STEEL TWIN SCREW MOTOR YACHT CRISTINA, DESIGNED BY HENRY J. GIELOW.
(Photograph, N. L. Stebbins, Boston.)

Aft of the engine room is the galley, fitted with stove, dressers, sink, dish racks and closets, with an ice-box and refrigerator (with a capacity of more than ½ ton of ice) and a gasoline (petrol) tank (capacity 2,000 gallons) just abaft the galley space. This tank, which is inclosed in a steel watertight compartment, is constructed of galvanized steel, with rivets and seams soldered. The capacity is such as to give the boat a cruising radius of 1,100 nautical miles at full speed, or 2,200 miles at 10 knots. On the starboard side is a passage leading from the saloon to the staircase up to the dining saloon.

The owner's quarters and staterooms for guests are located in the after half of the vessel. Immediately abaft the galley is the saloon, running the entire width of the hull, and 11 feet in length. Aft of this on the port side are two staterooms with a toilet room between them, while on the starboard side are the steerage and passage to the main deck, a stateroom with double berth and a bath room. Still further aft is the owner's stateroom, extending the full width of the vessel, and containing a double berth, two wardrobes and a bureau. The after end of the hull is allotted to general stores.

Propulsion is by twin screws, each actuated by a six-cylinder 100-horsepower engine, built by the Standard Motor Construction Company, of Jersey City. These engines are located forward beneath the dining saloon, and the long length of shafting makes it possible to place the axis of the propellers in a nearly horizontal line. The rudder is balanced, and the dead wood is cut away aft to such an extent as to make for easy handling. The maximum speed is about 13 knots.

Three boats are carried, one of which is itself operated by a small gasoline engine. There is an electric light plant in the engine room, and the boat is heated throughout by steam. Running water is supplied throughout the entire vessel, a fresh-water tank with a capacity for 100 gallons being located in the general store room aft. The bath room and toilet room floors are tiled, as are also the sides and bulkheads of these compartments.

Our illustrations will show that the vessel is most tastefully fitted up, and that a prime requisite in the design was the subject of comfort. The expanse of deck space aft of the funnel is such as to give plenty of room for lounging and for such entertainments as may be desired by the owner. The boat was launched July 31 last, and has already seen some little service.

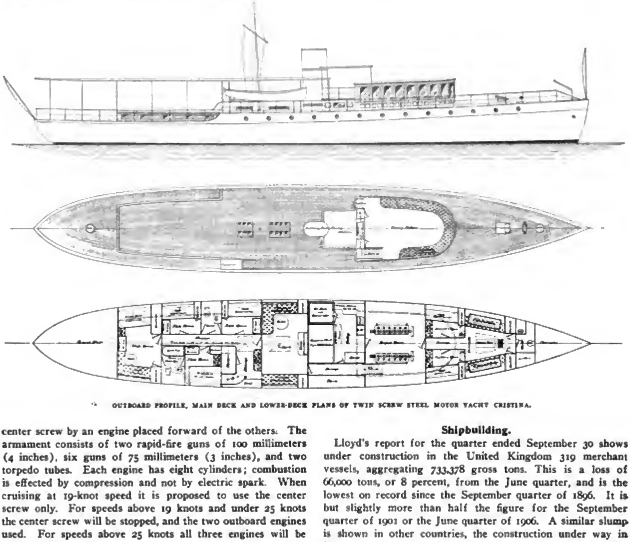
THE LIBRARY ON THE CRISTINA IS COSILY AND TASTEFULLY ARRANGED.—VIEW LOOKING TOWARDS PORT SIDE.
(Photograph, N. L. Stebbins, Boston.)

A New Petroleum Engine.

A French engineer, M. Sabathé, has in hand the preparing of designs for a torpedo boat destroyer of 500 tons displacement. The design calls for three screws, the outboard screws being operated by two engines placed in parallel, and the center screw by an engine placed forward of the others. The armament consists of two rapid-fire guns of 100 millimeters (4 inches), six guns of 75 millimeters (3 inches), and two torpedo tubes. Each engine has eight cylinders; combustion is effected by compression and not by electric spark. When cruising at 19-knot speed it is proposed to use the center screw only. For speeds above 19 knots and under 25 knots the center screw will be stopped, and the two outboard engines used. For speeds above 25 knots all three engines will be brought into play.

The designs call for a total engine weight of 220 tons, and at a speed of 14 knots the cruising radius is estimated at 4,800 nautical miles. The fore-and-aft length occupied by one of these engines of eight cylinders is 11 meters (36 feet), and the height from bed plate to top of cylinders is 2.9 meters (9½ feet). M. Sabathé estimates that 22 tons of petroleum will suffice for this vessel for a 1,200-mile run, assuming a 14-knot speed, and that the same vessel would use 52 tons of coal for this distance at the same speed. The calculations call for a petroleum consumption at this speed of 0.185 kilogram per horsepower per hour. It is estimated that this vessel will develop 850 horsepower effective when making 14 knots, and 9,200 horsepower effective when attaining a speed of 30 knots. An eight-cylinder engine of this design, when making about 300 turns per minute, will develop an effective horsepower of between 2,500 and 3,000.

For a vessel of 1,000 tons this engine can afford a maintained speed of 19 knots on an hourly consumption of petroleum of 0.19 kilogram per effective horsepower. For a reciprocating steam engine the coal consumption is estimated at 1.2 kilograms per effective horsepower. The designer says that these petroleum engines can be reversed in about twelve seconds without need of any special reversing engine. The cost of one of these 3,000-horsepower engines delivered at Havre is about 960,000 francs (£38,000, or $185,000).



OUTBOARD PROFILE, MAIN DECK AND LOWER-DECK PLANS OF TWIN SCREW STEEL MOTOR YACHT CRISTINA.

Shipbuilding.

Lloyd's report for the quarter ended September 30 shows under construction in the United Kingdom 319 merchant vessels, aggregating 733,378 gross tons. This is a loss of 66,000 tons, or 8 percent, from the June quarter, and is the lowest on record since the September quarter of 1896. It is but slightly more than half the figure for the September quarter of 1901 or the June quarter of 1906. A similar slump is shown in other countries, the construction under way in France being given as 44,803 tons; in Germany, 160,804 tons; in Italy, 43,070 tons; in Japan, 97,580 tons; and in the United States, 55,105 tons. This latter does not include the Great Lakes.

Under construction in the United Kingdom were shown 66 warships, aggregating 251,138 tons displacement. Eight of these are British and two Brazilian battleships; two, British armored cruisers; two British and two Brazilian scouts; while the balance are destroyers, submarines, etc.

The Bureau of Navigation in Washington reports the construction during the quarter ended September 30 of 319 vessels, aggregating 20,887 gross tons. Only thirteen of these vessels, aggregating 7,908 tons, were steel steamers. This is probably a low record for any quarter in the history of modern American shipbuilding. The corresponding figures for the 1907 quarter were 330 vessels of 133,092 gross tons, of which 36 vessels, aggregating 109,985 tons, were steel steamers. An interesting side light on the character of the construction this year is afforded by the fact that the steel steamers average only 608 tons, whereas last year the average was 3,055 tons, or more than five times as large.

INTERNATIONAL MARINE ENGINEERING

Published Monthly at

17 Battery Place New York

By MARINE ENGINEERING, INCORPORATED

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President

E. L. SUMNER, Secretary

and at

Christopher St., Finsbury Square, London, E. C.

E. J. P. BENN, Director and Publisher

SIDNEY GRAVES KOON, Editor

Branch Offices { Philadelphia, Machinery Dept., The Bourse, S. W. ANNESS. Boston, 170 Summer St., S. I. CARPENTER.

Entered at New York Post Office as second-class matter.

The edition of this issue comprises 6,000 *copies. We have no free list and accept no return copies.*

Rudders and Rudder Posts.

Some months ago we published in considerable detail a number of rudder designs from Pacific Coast practice of the United States and the practice of the Navy Department. These were largely warships, and all were large vessels.

In the present number we are fortunate enough to be able to supplement the previous article by another, covering practice on the Clyde in steamers of small and moderate size, including both screw, paddle-wheel and turbine propulsion.

The value of such articles, giving exact details on subjects of vital importance to the ship, can scarcely be over-estimated. The interchange of ideas resulting from the application to the problem of the minds of many engineers at widely separated points, and working under differing conditions, is of extreme value to everyone interested in the subject, and as such we commend both articles to careful perusal.

Society of Naval Architects and Marine Engineers.

The sixteenth general meeting of the Society will be held on Thursday and Friday, the 19th and 20th of November, in the Engineering Societies building, New York. A list of the seventeen papers prepared for discussion follows:

1. "The War Eagle," by Charles H. Cramp.
2. "Practical Methods of Conducting Trials of Vessels," by Col. E. A. Stevens.
3. "The Influence of Free Water Ballast upon the Stability of Ships and Floating Docks," by Naval Constructor T. G. Roberts, U. S. N.
4. "Further Experiments upon Longitudinal Displacement and its Effect upon Resistance," by Professor H. C. Sadler.
5. "Further Analysis of Propeller Experiments," by Clinton H. Crane.
6. "Deviation of the Compass Aboard Steel Ships; Its Avoidance and Correction," by Lieut.-Commander L. H. Chandler, U. S. N.
7. "The Influence of Midship Section Shape upon the Resistance of Ships," by Naval Constructor D. W. Taylor, U. S. N.
8. "Recent Inventions as Applied to Modern Steamships," by W. C. Wallace.
9. "Service Test on the Steamship *Harvard*," by Professor C. H. Peabody.
10. "Trials of the United States Scout Cruiser *Chester*, Fitted with Parsons Turbines," by Charles P. Wetherbee.
11. "Some Remarks on the Steam Turbine," by J. W. Powell.
12. "Shipbuilding on the Great Lakes," by Robert Curr.
13. "The Steamer *Commonwealth*," by J. H. Gardner and W. T. Berry.
14. "Fire Boats," by Charles C. West.
15. "Sea-Going Suction Dredges," by Thomas M. Cornbrooks.
16. "The British International Trophy Race of 1908," by W. P. Stephens.
17. "Transportation of Submarines," by Naval Constructor W. J. Baxter, U. S. N.

The papers are of unusual interest, three of them dealing with the newest and most prominent agent of ship propulsion—the steam turbine. In two of these three papers the subject of tests and trial trips is gone into extensively, and these two papers refer respectively to mercantile and war vessels. Two other papers, following in some measure papers by the same authors last year, relate to the resistance of ships; and both are based upon experiments with models conducted respectively in the government tank at Washington and the tank of the University of Michigan. The other papers are so scattered in general scope as not to be amenable to ready classification, but each is treated by an acknowledged authority on the subject, and the result ought to be a splendid list.

The Era of the Large Ship.

The advent of the Cunarders *Lusitania* and *Mauretania*, each of which has a gross tonnage more than 6,000 tons greater than any other ship afloat, was rightly heralded as marking a new era in the development of the large ocean steamship. Prior to these two ships the successive advances in tonnage had been relatively small, but continuous. Such a big jump as these two ships represented, however, was looked upon as setting the mark for some years to come. But their pre-eminence in this respect, it seems, is now challenged by the determination of the White Star Company to build two ships exceeding the two Cunarders in every dimension. These two vessels, which have already been named *Olympic* and *Titanic,* will be laid down by Harland & Wolff, in Belfast, next January.

Various statements have been made regarding their size; but it seems to be settled that they will be 860 feet long over all, and will have unusual beam and depth. The result is a ship with an estimated gross registered tonnage of 42,000, as compared with 30,822 for the *Lusitania* and 31,938 for the *Mauretania.* When we consider that, aside from the four ships mentioned, there has never been built a ship reaching as much as 25,000 gross tons, the tremendous stride in advance in this respect is at once apparent. The new ships, it is reported, will have a speed of about 21 knots, and will be furnished and decorated in most superior style. They are expected to be ready for the summer season of 1910, and will, naturally, be fitted to handle an enormous cargo.

It is interesting in this connection to note that the average length of the twenty largest steamships of the world in 1848 was only 230 feet; in 1873, twenty-five years later, the average was 390 feet; after another quarter-century the average length of the twenty largest was 541 feet, while it was 640 feet in 1903;

	Ship.	Launched.	Line.	Length, Feet.	Gross Tonnage.
1	*Olympic**	1910	White Star	860	42,000
2	*Titanic**	1910	White Star	860	42,000
3	*Mauretania*	1906	Cunard	760	31,938
4	*Lusitania*	1906	Cunard	760	30,822
5	*George Washington* †	1909	North German Lloyd	700	24,800
6	*Kais. Augusta Victoria.*	1905	Hamburg-American	678	24,581
7	*Adriatic*	1906	White Star	709	24,541
8	*Rotterdam*	1907	Holland-America	650	24,176
9	*Baltic*	1904	White Star	709	23,876
10	*Amerika*	1905	Hamburg-American	669	22,225
11	*Cedric*	1902	White Star	681	21,035
12	*Celtic*	1901	White Star	681	20,904
13	*Minnesota*	1904	Great Northern	622	20,718
14	*Caronia*	1905	Cunard	650	19,687
15	*Carmania*	1905	Cunard	650	19,524
16	*Kaiser Wilhelm II.*	1902	North German Lloyd	684	19,361
17	*Kronprinzessin Cecilie*	1907	North German Lloyd	684	19,360
18	*President Grant*	1907	Hamburg-American	600	18,074
19	*President Lincoln*	1907	Hamburg-American	600	18,074
20	*Lapland* †	1908	Red Star	620	18,000
21	*Oceanic*	1899	White Star	686	17,274
22	*Prinz Friedrich Wilhelm*	1907	North German Lloyd	590	17,082
23	*Nieuw Amsterdam*	1906	Holland-America	600	16,913
24	*Deutschland*	1900	Hamburg-American	661	16,502
25	*Cincinnati* †	1908	Hamburg-American	580	16,400
26	*Cleveland* †	1908	Hamburg-American	580	16,400
27	*Arabic*	1903	White Star	601	15,860
28	*Republic*	1903	White Star	570	15,378
29	*Kronprinz Wilhelm*	1901	North German Lloyd	637	14,908
30	*La Provence*	1906	French	603	14,744

Ships not yet afloat are marked (*); those afloat but not yet in service (†). It will be noted that six of the first eleven are White Star ships, as are nine of the thirty. Seven belong to the Hamburg-American Line.

in 1909, including the two new ships, the figure is 691 feet. The mean gross tonnage of these twenty largest ships is 24,285, as compared with 17,151 in 1903. If we average the lengths of the twenty *longest* ships, we have 700 feet; but three ships here included, being long and narrow, and intended largely for speed, do not appear among the twenty *largest,* reckoned in gross register tonnage.

As a matter of interest, the thirty largest ships, averaging 665 feet in length and 21,575 tons gross register, are listed below. It may be noted that the *Cedric,* now eleventh on the list, was, as recently as 1903, the largest ship afloat. In 1899 this distinction was held by the *Oceanic,* now twenty-first in tonnage. A large steamer not listed is the *Europa,* of the Hamburg-American Line. This vessel has been projected for some time, but, we believe, is not actually under construction.

Theoretical Considerations.

The practical shipbuilder is prone to look with more or less scorn upon theoretical methods and processes. His work lies in transmuting the ideas of the designer, as represented by the drawings of a ship and her machinery and equipment, into a steel structure capable of battling with the elements of nature, and of carrying her load—be it passengers, cargo or warlike material—from place to place at a predetermined speed and under certain conditions of economy.

In the development of the design, however, it is necessary to investigate theoretically certain features regarding the adaptability of the proposed structure to the purposes intended. One of the most important of these has to do with the stability of the ship, and anything which would tend to decrease the onerous task of determining this directly from the lines and disposition of weights is welcomed as a boon by those who have the task in hand. An article on this subject in another column is quite opportune, and may be recommended to the careful consideration of naval architects generally.

Another matter, which is much less likely to receive attention than is the question of stability, is that concerning the adequacy of the riveted connections in the shell plating to take up their share in the burden imposed upon the structure of the ship by the motion of the waves, and by the relation between the buoyancy of the water, directed upwards, and the various component weights of the ship and her contents, directed downwards. An article on this subject will also be found in our pages this month, in which the matter is taken up theoretically but simply, and the subject is gone into in sufficient detail to show the methods employed in the Navy Department in Washington. It is obvious that the material and its connections should be properly proportioned to bear the loads to which they are to be subjected.

Progress of Naval Vessels.

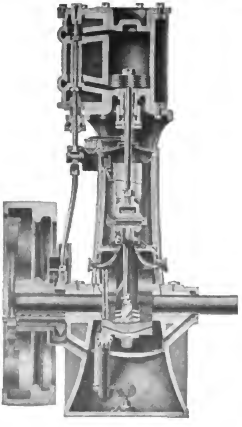
The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

	Knots.	Tons.		Sept. 1.	Oct. 1.
BATTLESHIPS.					
S. Carolina..	16,000	18½	Wm. Cramp & Sons........	58.1	63.2
Michigan ...	16,000	18½	New York Shipbuilding Co..	65.1	71.4
Delaware ...	20,000	21	Newp't News S B & D.D. Co.	40.5	44.2
North Dakota	20,000	21	Fore River Shipbuilding Co.	50.1	54.2
TORPEDO BOAT DESTROYERS.					
Smith	700	28	Wm. Cramp & Sons........	49.3	53.8
Lamson	700	28	Wm. Cramp & Sons........	46.7	52.1
Preston	700	28	New York Shipbuilding Co..	47.9	49.1
Flusser	700	28	Bath Iron Works...........	20.1	26.1
Reid	700	28	Bath Iron Works...........	20.1	26.0
SUBMARINE TORPEDO BOATS.					
Stingray	—	—	Fore River Shipbuilding Co..	56.7	58.7
Tarpon	—	—	Fore River Shipbuilding Co..	54.5	57.3
Bonita	—	—	Fore River Shipbuilding Co..	54.1	55.5
Snapper	—	—	Fore River Shipbuilding Co..	53.8	55.7
Norwhal	—	—	Fore River Shipbuilding Co..	48.2	50.9
Grayling	—	—	Fore River Shipbuilding Co..	47.9	50.7
Salmon	—	—	Fore River Shipbuilding Co..	46.8	50.3

ENGINEERING SPECIALTIES.

Economy Tests of High-Speed Engines.

In a paper read by C. H. Treat, before the American Society of Mechanical Engineers, he gave complete data on a test made July 9 and 10 on a 7 by 7-inch vertical self-oiling engine, which had been run almost continuously, night and day, for 10.000 hours, connected to a forced draft fan. The engine cylinder had been badly scored, and the mean diameter increased to 7.082 inches. The rings had been broken, due to water, and were replaced prior to test. The test shows results as low as 41 pounds of steam per indicated horsepower per hour under full load. This performance, it will be noted, is as good as many new engines in their best condition would show. A further observation leads to the belief that it is quite important from an economical point of view to keep the piston rings on small high-speed engines in shape to prevent undue leakage.



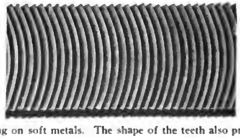
The initial tests on this engine were made at the plant of the American Blower Company, Detroit, Mich., in 1905. Test was made by condensing the exhaust in a surface condenser, consisting of steam heater section pipe immersed in a tank, having an overflow. The whole was up overhead, so that any drip or leaks could be seen and stopped. That the section itself did not leak at any time was shown by the entire absence of drip, unless steam was entering.

The condensation being piped down, heater pipes and base were slanted to drain through a water seal to prevent steam blowing into the upper of two barrels having drain valves at bottom, the lower barrel being on platform scales. For each barrel of water the weight before filling was subtracted from the full weight. The scales used weighed correctly. The indicator spring was calibrated by both the makers and observers. A long lever reducing motion was used to prevent lost motion. The drum spring was drawn tight, and at the high speeds cards were short. The engine was indicated at speeds up to 500 revolutions per minute; using a Prony brake at higher speeds and taking the brake horsepower. Readings were taken every five minutes after conditions had become constant and the engine was well warmed up. No corrections were made for moisture in steam, but a few determinations showed a quality of 98 to 99 percent.

The section of engine shows the arrangement of cylinder and valve chest, also the unique patented oiling system. Mr. Treat's test of the used engine gave the indicated friction horsepower as 1.18, this being only 4 percent of the indicated horsepower of the engine. The oiling system must receive much credit for keeping the internal friction at such a low percentage.

The Vixen Patent Milling File.

The "Vixen" patent milling file has semi-circular teeth on both sides, cut especially deep, which give to the filings the nature and shape of turnings or shavings produced by a modern lathe or milling machine. A special back, or holder, is used in conjunction with the file, which enables the mechanic to get a much greater purchase, and so to utilize to the fullest extent the superior cutting qualities of the file. The shape of the teeth not only makes the file act essentially as a milling cutter, but it also tends to keep the file clean, an object which is hard to accomplish with an ordinary file, especially when

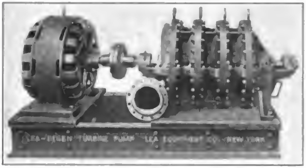


working on soft metals. The shape of the teeth also prevents the file from slipping or chasing, and leaves a smooth, even surface. It is claimed that the file cuts equally well soft and tool steel, cast and wrought iron, bronze and all other hard metals, as well as brass, lead, aluminum and other soft metals. The file can be resharpened at least four times, each operation costing about half that of recutting an ordinary file. Moreover, it is claimed that, after resharpening, the file is quite as good as new, and, therefore, may be expected to last several times as long as an ordinary file. This file is manufactured by the National File & Tool Company, the Bourse, Philadelphia, Pa., and 8 White street, Moorfield, London, E. C.

A High-Duty Turbine Pump.

A pump which has been developed by the Lea Equipment Company, 136 Liberty street, New York, and is intended to be used largely in marine work, is operated by an induction or other type of electric motor, and runs through four stages, each of which is a separate unit and may readily be removed. It is said that no trouble is experienced from end thrust, the pump being so designed as to take care of this automatically. The present line of pumps includes those with suction and discharge from 3 to 24 inches in diameter.

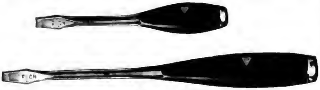
A 10-inch two-stage pump of this type, with eight blades, driven by a General Electric direct-current multipolar motor,



operated at 220 volts and with a capacity of 385 amperes, has been tested for efficiency at 400, 500 and 600 revolutions per minute. This pump was designed to deliver 3,000 gallons per minute, with a total head of 100 feet, at 600 revolutions per minute. The maximum efficiency at this speed was 77.97 percent when delivering 3,235 gallons per minute. The efficiency was above 70 percent for delivering all the way from 1,800 to 3,730 gallons per minute. At 500 revolutions the maximum efficiency of 77.62 percent was reached with a delivery of 2,794 gallons per minute. The efficiency was over 70 percent for all deliveries from 1,510 to 3,400 gallons per minute. At 400 revolutions per minute a maximum efficiency of 77.7 percent was reached with a delivery of 2,296 gallons per minute. The efficiency was above 70 percent for all deliveries from 1,250 to 2,850 gallons per minute.

An All-Steel Screwdriver.

A new and improved screwdriver, complete in one piece, is drop-forged of steel throughout, and the point is carefully tempered. The handle is of special design, insuring a positive and easy grip. There is nothing about it to loosen or get out



of order. It is simple, light, effective and durable. These screwdrivers are manufactured by the Billings & Spencer Company, Hartford, Conn., and are listed in eleven sizes, including two of heavier model, with square shank, for the application of a wrench.

PERSONAL.

Charles Ackerman, formerly general manager of the Crescent Shipyard (Lewis Nixon's) at Elizabethport, N. J., and later general manager of the Vacuum Cleaner Company, New York, is now general sales agent of the Mosher Watertube Boiler Company, with offices at 30 Church street, New York.

TECHNICAL PUBLICATIONS.

Nautical Charts. By G. R. Putnam, M. S. Size, 5¾ by 9 inches. Pages, 162. Figures, 49. 1908, New York: John Wiley & Sons. Price, $2.00; and London: Chapman & Hall, Ltd. Price, 8/6 net.

This work is based primarily on a lecture on charts, delivered before Columbia University. It deals with the methods of collecting and preparing information for the making of charts, their publication in the form of copper plates, their subsequent correction, and the reading and use of charts as an indispensable aid to navigation. It is shown in detail how soundings are taken and plotted, and how, from the original sounding charts, the finished charts are prepared, with various shadings for various depths of water, and selected soundings printed from the great mass taken. The various instruments used for this purpose, both for the actual soundings and the location of the point at which each sounding is taken, are illustrated and described, with considerable information regarding the process of triangulation, and the plotting of the results on various styles of projection, such as the mercator, the polyconic, the gnomonic and the arbitrary projection usually used for polar regions.

The subject of copper-plate engraving and printing is given quite a little attention, illustrations showing the methods of engraving the chart originally, and of engraving by means of a machine the various soundings on the copper plate. Electrotyping processes and lithographing processes are also illustrated, and etching on copper by means of a finished tracing and a sensitized copper plate is given some attention. In connection with the continual changes in channels, it is pointed out that the average loaded draft of the twenty largest steamships in the world increased from 19 feet in 1848 to 24 feet in 1873, 29 feet in 1898 and 32 feet in 1903. The average length of these vessels increased, respectively, from 230 feet to 390 feet, 541 feet and 640 feet.

Steam Power Plant Engineering. By G. F. Gebhardt, Professor of Mechanical Engineering, Armour Institute of Technology, Chicago. Size, 5¾ by 9 inches. Pages, 816. Figures, 461. 1908, New York: John Wiley & Sons. Price, $6.00 net; and London: Chapman & Hall, Ltd. Price, 25/6 net.

This book is the outcome of a series of lectures delivered to the senior class of the Armour Institute, and is primarily a text-book for engineering students, but also of interest to practicing engineers. The field embraced by the title is such a large one that it has been necessary to limit the treatment to essential elements only.

The work is divided into twenty-one chapters and six appendices, covering in rotation elementary considerations, fuels, boilers, furnaces and stokers, superheated steam, coal and ash-handling apparatus, chimneys, mechanical draft, steam engines, steam turbines, condensers, feed-water heaters, pumps, superheaters, piping, lubrication, finance and economics, instruments, typical specifications, a typical steam turbine station and a typical isolated station.

The work is full of references to original sources of information, particularly to current technical magazines; and the illustrations have been drawn from a great variety of sources, covering practice of all sorts all over the United States. Many of the illustrations are charts of performance, relating results to consumption of fuel and general cost of production and power.

In some respects the two last chapters, dealing, respectively, with the Commonwealth Edison Company, of Chicago, and the West Albany Power Station of the New York Central Railroad, are the most interesting of the work. Each deals with a thoroughly successful and up-to-date plant, the two plants considered being of totally different character, and markedly different in size. The installations are described in

some detail, while the illustrations give a good idea as to the layout and general equipment of the plants.

Ex-Meridian Altitude, Azimuth and Star-Finding Tables. By Lieutenant-Commander Armistead Rust, United States Navy. Size, 6¼ by 9½ inches. Pages, 393 + li. Figures, 13, including six folding plates. 1908, New York: John Wiley & Sons. Price, $5.00; and London: Chapman & Hall, Ltd. Price, 21/- net.

This work is not a text-book, and, therefore, rules for the conversion of time, the finding of hour angles and for plotting lines of position by the usual methods familiar to navigators, and which may be found in any work on navigation, have been omitted. A few examples have been worked, however, to illustrate the use of the various tables and diagrams.

The tables are so arranged that the "reduction to the meridian" may be found with sufficient accuracy for practical navigation at one opening of the book, while means are provided for readily obtaining the azimuth and correcting the reduction for variations in all of the elements when extreme accuracy is required. A new formula for the equation of altitudes for finding the chronometer error will, it is said, be found more convenient than that in general use, and the formula given for finding the longitude from ex-meridian observations has, it is believed, been reduced to such a simple form as to make it most useful when the weather has been too cloudy to obtain the longitude in any other way, or when the ship is in a region of strong currents.

The entire list of numbered pages is occupied by tables. In addition to these, twenty-five pages of the prefix are covered by tables of logarithms and corrections to be applied to the main tables. The first twenty-six pages of the prefix give methods for using the tables and plates and explanations of the same.

Verbal Notes and Sketches for Marine Engineers. By J. W. Sothern. Size, 5½ by 8½ inches. Pages, 438. Figures, 300. Glasgow, 1908: James Munro & Company. Price, 7/6 net and $2.25.

This is the sixth edition, and the main difference from the fifth is in the shape of additions covering indicator diagrams, valve settings, condensers, centrifugal pumps, steering gear, refrigeration, etc.

The work is in eight sections, covering respectively boilers, engines, general notes on materials and implements, indicator diagrams, marine electric lighting, refrigerating machinery, screw propellers and oil motors. It covers the subject from the point of view of the operating marine engineer, and is especially arranged to suit Board of Trade regulations, and to serve as a general reference book for marine engineers. It includes notes and sketches of verbal questions given at Board of Trade examinations to engineers competing for first-class and second-class certificates of competency.

The subject appears to be thoroughly practical in every sense, much of the material having been furnished by specialists along the particular lines represented. It includes a great variety of subjects, covering all sorts of material in which the marine engineer is interested, from the taking of indicator cards to the measurement of the pitch of a propeller, the adjustment of a lighting set and the operation of air compressors and ice machines. A short appendix gives the usual properties of saturated steam at pressures up to 200 pounds absolute per square inch.

The steamboat *New York*, of the Albany Day Line, one of the finest river steamers in the world, was totally destroyed by fire early in the morning, October 21. The vessel was built in 1887, was 335 feet long, and propelled by paddle wheels at a maximum speed of about 21 miles per hour.

QUERIES AND ANSWERS.

Questions concerning marine engineering will be answered by the Editor in this column. Each communication must bear the name and address of the writer.

Q. 418.—Is there any convenient formula for estimating the weights of marine boilers from known data of the boilers? Y. K. N.

A.—A paper read in 1897 before the Society of Naval Architects and Marine Engineers, and republished in our columns in February and June of 1898, gives formulas for Scotch, low cylindrical and locomotive boilers, including their respective mountings. Separate formulas are given for water in these boilers. The formula in each case covers one boiler only.

For single-ended Scotch boilers, the weight in tons (2,240 pounds) is $0.0075\ [D^2\ (L + 2) + H.\ S.] + 1.5$.

For double-ended Scotch boilers, weight $= 0.0075\ [D^2\ (L + 2) + H.\ S.]$.

For locomotive boilers, weight $= 0.0075\ [D^2\ (L + 2) + H.\ S.] - 1.5$.

For single-ended low cylindrical boilers, weight $= 0.005\ [D^2\ (L + 2) + H.\ S.] + 8$.

For double-ended low cylindrical boilers, weight $= 0.005\ [D^2\ (L + 2) + H.\ S.] + 6.5$.

For water in the main boilers other formulas are used. In Scotch boilers, with water 8 inches above the top row of tubes, the weight $= 0.0117\ (D^2\ L - A)$.

In low cylindrical boilers, with water 6 inches above top row of tubes, weight $= 0.01\ (D^2\ L - B)$.

In locomotive boilers, with water 6 inches above the furnace crown, weight $= K\ (D^2\ L - C - 125)$.

For auxiliary boilers, including contained water, the weight, for both horizontal and vertical types, may be placed at $0.031\ D^2\ L$.

In the above formulas the following notation is used:

D = Mean diameter in feet.
L = Length over end plates in feet.
$H.\ S.$ = Total heating surface of the boiler in square feet.
$T.\ S.$ = Tube heating surface in square feet.

$$A = \frac{H.\ S. \times d}{12\ \pi} + n f^2\ l.$$

$$B = \frac{H.\ S. \times d}{12\ \pi} + n f^2\ (L - l).$$

$$C = \frac{T.\ S. \times d}{12\ \pi}$$

d = Diameter of tubes in inches.
l = Length of tubes in feet.
f = Maximum diameter of furnaces in feet.
n = Number of furnaces in one boiler.
K = 0.028 for boilers with dry bottom and one furnace; 0.03 for two furnaces; 0.032 for boilers with wet bottom and one furnace, and 0.034 for two furnaces.

It will be noted that the tons per inch at above levels of water will be approximately $0.0021\ D\ L$.

These formulas are part of a large number, going into the estimated weights of machinery for both warships and merchant steamers. They have been computed from the recorded detail weights of machinery of more than three hundred vessels, embracing almost all of the types found in service, and have been found to give very close results in practice. In a number of cases, where Scotch, locomotive and low cylindrical

boilers were fitted, the estimated weights of machinery complete were found to come within 3½ percent of the actual recorded weights. In computations for 115 separate ships there were only eleven cases where the error exceeded the above percentage.

SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

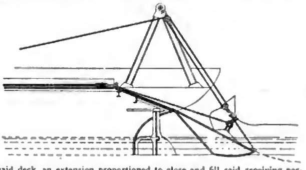
American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

893,324. SAFETY DEVICE FOR VESSELS. PAUL JAMNITZKY, CONEMAUGH, PA.

Claim 1.—The combination of a vessel having compartments formed therein, of air compressors, reservoirs for receiving air from said compressors, pipes for supplying air to the numerous compartments of said vessel, frames arranged longitudinally upon the bottom of said vessel, members at the ends of said frames for providing a compartment beneath said vessel when aground, hoods arranged in the bottom of said vessel and communicating with said reservoir, gates arranged in said hoods for controlling the direction of the discharge of air in said hoods, and a frame arranged upon the deck of said vessel for discharging air and dispelling fog surrounding said vessel. Three claims.

893,642. VESSEL FOR WHALE FISHING. JENS A. MORCH, CHRISTIANIA, NORWAY.

Claim 2.—In combination, a hull provided with a deck and having its stern recessed to form a receiving portion inclined downwardly from



said deck, an extension proportioned to close and fill said receiving portion when in a non-operating position, and adapted to form a continuation of said receiving portion when in an operating position, means mounted on said hull for operating said extension, and means mounted on said hull for drawing a load over said extension and inclined portion onto said deck. Five claims.

896,087. LIFE-SAVING APPARATUS. JOHN W. NEELY, CAMBRIDGE, MASS., ASSIGNOR OF ONE-HALF TO JOHN H. SMITH, JAMAICA PLAIN, MASS.

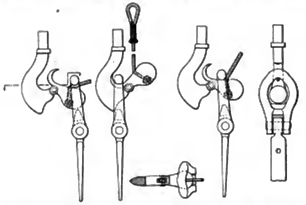
Abstract.—The invention relates to improvements in life-saving apparatus, and the object is to provide a device which may be worn by a person who is either boating or who is near the water, said device comprising a float and a cord fast to said float coiled and supported on a belt in such a manner that if the person's body becomes submerged the float will free itself from the belt and rise to the surface, thus indicating the position of the body, so that the body may be raised by means of the cord. Four claims.

896,349. STOCKLESS ANCHOR. WALTER S. BICKLEY, CHESTER, PA.

Abstract.—The invention has for its object to improve this class of anchor and to strengthen the head. A further object of the invention is to produce an anchor of this character that can readily be made of cast steel, which will make it equal to a wrought iron anchor, being ductile and of equal strength of forging. One claim.

894,345. DEVICE FOR ATTACHING AND DETACHING BOATS. JAMES R. RAYMOND, BAYONNE, N. J.

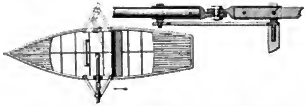
Claim 1.—The combination in a boat attaching and detaching device, of a movable hook having a neck and an enlarged bill, a shackle adapted



to engage said neck, and a lanyard adapted to guide said shackle to place on said neck and secured to said hook at a substantial distance back of said enlarged bill, whereby the lanyard in hooking on prevents direct engagement between said bill and shackle, and guides said shackle on to the neck of said hook. Six claims.

896,863. ROWING APPLIANCE. WILLIAM F. JAMES AND WILLIAM T. DEACON, VELASCO, TEXAS.

Claim 1.—In a rowing appliance for row-boats, a bracket consisting of outwardly-converging arms connected together and having means connecting the free ends thereof to the boat, permitting of a limited swinging movement of the bracket vertically, an oar-lock supported in the



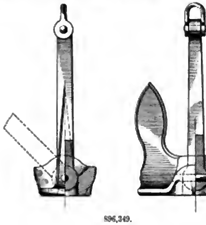
connecting portions of said arms, an oar-lock revolubly supported by the boat between said arms, and an oar passing through the oar-locks, composed of two sections pivoted together between said locks, adapting the sections of the oar to swing laterally. Four claims.

898,094. BOAT-LASHING DEVICE. FRED T. CLAYTON, SANDWICH, MASS., ASSIGNOR OF ONE-HALF TO ROBERT A. HAMMOND, SANDWICH, MASS.

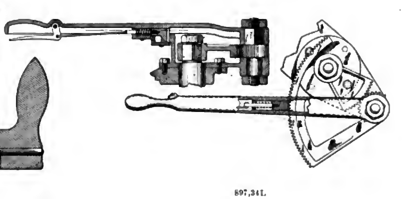
Claim 1.—A device for lashing a boat to the deck of a vessel, comprising in its construction a link, the opposite ends of which are adapted to be pivotally connected, respectively, to a fixture fast to said boat and a fixture fast to the deck of said vessel, said link consisting of a rod, a latch pivoted to one end of said rod, said latch having a cam-shaped inner edge adapted to bear against said first-named fixture for the purpose specified, and means to lock said latch to said rod. Two claims.

897,341. PROPELLER-ADJUSTING DEVICE. WILLIAM E. BLAIR, BUFFALO, N. Y., ASSIGNOR TO BUFFALO GASOLINE MOTOR CO.

Claim 1.—A propeller-adjusting device comprising a main driving shaft, propeller blades adjustably supported on said shaft, a shifting rod movable lengthwise of the shaft and operatively connected with the propeller blades, an adjusting shaft arranged at an angle to the driving shaft and adjusting rod and operatively connected with said rod, a counter shaft arranged parallel with the adjusting shaft, a large gear secured to the adjusting shaft, a small gear secured to the counter shaft and meshing with the large gear, and a hand lever connected with the counter shaft. Five claims.



896,349.



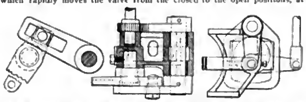
897,341.

British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

4,576. ELASTIC-FLUID TURBINES. C. H. RAWSON, AND BUCHHOLTZ REVERSIBLE TURBINE SYNDICATE, LONDON.
In a multiple expansion reversible turbine, rotatable disks mounted on a shaft alternate with fixed disks secured to the casing. An annular series of blade passages is formed in each rotatable disk, and similar guide passages are formed in the fixed disks. To allow for expansion, the radial depth of the passages increases in a step-like manner, or the increase may be gradual. The turbine is made reversible by means of a ring of perforations in each rotatable disk, and a corresponding ring of perforations in each fixed disk, the former being inclined to the plane of the disk, and the latter being parallel to it. Oppositely arranged inlets and outlets are provided for forward and reversed driving respectively.

4,839. STEERING GEAR. T. L. LIVINGSTON, JARROW-ON-TYNE.
Two driving means are provided for operating the rudder, both of which are always in gear and may be brought into operation either separately or simultaneously. The modifications comprise means whereby the stop nut on one motor is actuated by operating the other motor, in such a manner that the traveling stop nuts in connection with each motor always correspond with each other and the angle to which the rudder is moved.

5,264. STEERING ENGINES. W. G. GIBBONS, EDINBURGH.
The controlling gear transmits its motion to the valve by mechanism which rapidly moves the valve from the closed to the open positions, at

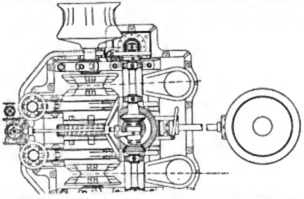


which positions the gear is free to continue its movement without substantially moving the valve. The controlling-valve lever is slotted, and is operated by a block on the pin attached to the small arm of the crank. In the open position the movement of the crank has substantially no effect on the valve. In a modification, the spindle operates a second spindle through a toothed sector and pinion. The second spindle is connected to the controlling valve. In another arrangement the movement of the lever is transmitted to a bridle by an eccentric. The bridle is connected to the valve by a spindle, lever and links.

6,321. RAISING SUNKEN SHIPS. B. REINIER, VIDAUBAN, FRANCE.
A cylinder for raising sunken ships is sunk by opening an air cock. Water then enters through a siphon tube, which is bent so as to form a water seal in any position of the cylinder; or water may be allowed to enter through a cock. When the cylinder is full, the cock is closed. In order to refloat the cylinder, air is forced in through a second siphon tube, water escaping through the first tube. Water in either end of the cylinder runs into the manhole chamber through tubes, and thence to the outside through the exit. Cocks are provided for screwing on connecting pipes for the combined working of several cylinders.

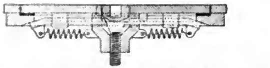
6,640. TURBINES. BELLISS & MORCOM, AND R. K. MORCOM, BIRMINGHAM.
Relates to making and fixing blades for turbine rotors and stators. Thin metal stampings are bent so as to form the front and back plates or surfaces of two adjacent blades connected by a foot, the plates being also united by one or more thin distance pieces; the back plate may have a strengthening rib. The blades are formed by assembling a number of these blade elements, the feet being secured in undercut grooves by bifurcated retaining blocks and a stringer, which spreads the fangs and flattens the arched foot. The widths of the front and back plates may vary, so that the edge of the blade, which may be sharpened, may have one or two thicknesses of metal.

6,880. WINDLASSES; CAPSTANS. A. KELLY AND C. D. B. HANSEN, GLASGOW.
Two-speed transmission gear is fitted between the engines and the



horizontal drum shaft of a windlass or capstan. The horizontal shaft carrying the cable drums and warping drums is driven from the engines through two-speed bevel and worm gearing. The worm is mounted on a vertical shaft carrying toothed wheels at its upper end, engaging the loosely mounted bevel wheels on the engine shaft.

6,999. SHIPS' HATCHES AND HATCHWAYS. P. B. CLARKE, LIVERPOOL.
Relates to ships' hatches, etc., in which the covers are flush with the

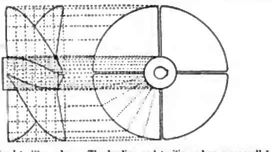


deck when in place, and the framing is provided with an inclined surface which is adapted to be engaged by the inclined outer ends of the sliding locking-bolts. To the deck is fixed a ledge, and between this and the hatch cover is a strip of india-rubber packing. The bolts are adapted to slide in guides in the hatch cover and the fitting. When the tapered bolt is screwed down, it pushes the other bolts outwards and forces their downwardly inclined edges under and against the inclined faces of the ledges, thus making a tight joint.

7,647. SHIPS. A. F. YARROW, POPLAR, LONDON.
In order to keep ships' cabins cool in hot climates, the tops are covered with loose canvas, woven reeds, or other suitable material that absorbs moisture. One or more revolving sprayers supply water from the river or sea to the material, and the evaporation serves to keep the surrounding space cool.

7,955. TURBINES. A. J. B. LEGE, ISLINGTON, LONDON.
Impact wheels are arranged for multiple expansion. A piston part or bucket attached to a disk is acted on by steam introduced through nozzles. After acting on the bucket the steam passes through nozzles in the fixed ring and impinges against similar buckets or piston parts. It next passes through nozzles to other buckets, and exhausts through ports. The disk carries piston parts on both sides. The piston parts may be formed with nozzle-like apertures so that fluid passing through reduces the pressure in front of the piston part. Labyrinth packing is provided where necessary. For reverse driving, steam is admitted to a central chamber, and is delivered by nozzles to buckets. It exhausts through ports, or may pass through openings in the ring to the general exhaust, or may even act further on the ahead buckets.

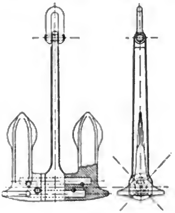
8,049. SCREW PROPELLER. D. McLACHLAN, CARDIFF.
The blades of the propeller are helical and have radial leading edges



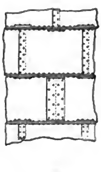
and inclined trailing edges. The leading and trailing edges are parallel to one another or nearly so, when viewed end on, and spring from a cylindrical boss.

9,201. SCREW PROPELLER. J. STRAKA, TRIESTE, AUSTRIA.
In the type of propeller in which the blades are surrounded by and secured to a circumferential ring, the blades are constructed with sharp and nearly straight leading edges and curved following edges, the width of the blades decreasing to the center of the propeller.

9,211. ANCHOR. J. B. RICHARDSON AND D. S. HOLLOWAY, PONTYPRIDD, GLAMORGAN.
The head is divided into two parts, united by one or more bolts, which pass through a recess in the shank. The bolts are secured to the arms by pins, or they may pass right through the arms and be riveted or otherwise secured at the ends. To avoid bending of the bolts a block is fitted in the shank, and is of such shape that the side of the chamber always contacts with it. The bolts may be in one with the block.



9,211.



9,280.

9,280. CHANNEL-PLATE CONSTRUCTIONS. A. JEFFREY AND J. V. KEANE, COTTESLOO, WESTERN AUSTRALIA.
Ships' hulls, bulkheads and decks, and other analogous plate structures are built up of plates of channel section, riveted or bolted together through the flanges, which thereby form ribs to the structure. The ends of the plates are riveted together by lap joints, or by butt joints reinforced by strap plates. In the construction of ships' hulls, the joints may run either longitudinally or vertically.

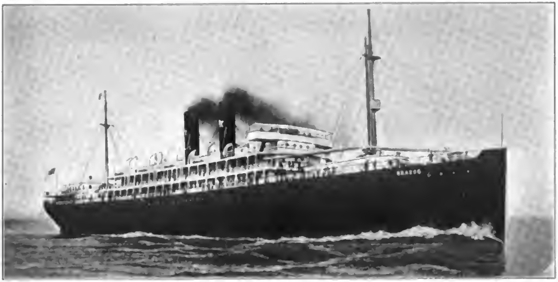
International Marine Engineering

DECEMBER, 1908.

THE MALLORY LINE STEAMSHIP BRAZOS.

BY SIDNEY GRAVES KOON.

This new steel twin-screw steamer has been built by the Newport News Shipbuilding & Dry Dock Company, under the general supervision of Theodore E. Ferris, of Cary Smith & Ferris, New York. The plans were worked up in collaboration with Charles Mallory, and, later, H. H. Raymond, general manager of the line. She sailed from New York to Galveston on her maiden voyage Oct. 3. She was built under special survey of the Bureau Veritas. She is of the hurricane deck type, with straight stem and elliptical stern, and is schooner-rigged, with two steel pole masts.



THE NEW MALLORY LINE STEAMSHIP BRAZOS AT SEA.

The ship has a length over all of 418 feet, a length between perpendiculars of 400 feet, a molded beam of 54 feet, a depth to hurricane deck of 37 feet, to main deck 28 feet 10 inches, and to lower deck 19 feet 6 inches. Her load draft is 24 feet, at which the displacement is about 10,000 tons. The net registered tonnage is 4,077, and gross tonnage 6,399. She is fitted with bilge keels for about half length, consisting of 15-inch plates 5/8 inch thick.

The ship is constructed with a partial double bottom under the boiler space, with ballast and fresh-water tanks for boiler feed of 300 tons capacity; and, in addition, tanks for culinary use of 64 tons and peak tanks of 240 tons capacity for water ballast or fresh water. The arrangement of weights is such that at full load the vessel trims 2 feet by the stern. The total cubic feet of cargo space is about 335,500, equivalent to 10,500 bales of cotton. The bunker capacity is for 1,430 tons of coal. At full-load draft and carrying 1,150 tons of coal, 200 tons of feed-water and 80 tons of stores, passengers and crew, the schedule of weights allows for 4,200 gross tons of freight. With 3,200 tons of freight, and the same provision for coal, etc., the draft is 22 feet. At this draft the sustained sea speed between New York and Galveston was estimated at 15½ knots.

As mentioned, there is only a single bottom outside the boiler room. Five transverse watertight bulkheads to main deck divide the hull into six compartments, but it is noteworthy that the bulkhead between engine and boiler rooms is not watertight. The frames (angles and reverse bars) are spaced 26 inches between centers. Deep frames are fitted on all watertight bulkheads. Web frames, built up of plates and angles, are fitted below the main deck where needed in the machinery space, and are fitted about seven frame spaces apart in the holds. They are also fitted in way of cargo ports between the lower and main and the main and hurricane decks.

The ship has a total of six decks, the lowest being an orlop in the No. 1 hold. There are complete lower, main and hurricane decks; a promenade deck over all deck houses; a boat deck over the amidships deck house. The crown of the deck beams, all of which are of channel section, supported by two continuous girders with wide-spaced stanchions built up of channels, is 12 inches in the total width of 54 feet, while

the tumble-home of the sides is 12 inches at the hurricane deck. The lower and main decks are completely plated, and no wood decks are fitted thereon; a 2½-inch calked wood deck is fitted on the orlop deck beams. On the hurricane deck a wide stringer is fitted to take the coaming plate of the deck house, and the balance of the deck is plated over with 5-pound steel, the whole being covered with a 3-inch Oregon pine calked deck.

For the storage of cargo there is one hold forward, below the orlop deck; one hold forward of machinery space below lower deck, and one similarly situated aft of machinery space. The 'tween deck compartments include one on the orlop deck; three on the lower deck, of which two are forward, and one aft of the machinery, and compartments forward and aft of machinery on the main deck.

For the passage of cargo to these compartments a number of hatches and cargo ports are fitted. The two principal hatches stretch from side to side of the ship, and are of unusual construction. The side plating between the hurricane and main decks is swung back in the shape of double doors, while the deck plating across the hurricane deck is lifted up in sections, leaving an enormous hole for the reception and passage of cargo. In addition to these two main hatches there are three center-line hatches on the main deck forward of the machinery space and two aft of the machinery space, as well as two small side hatches just aft of the engine room. One of the forward hatches extends up through the hurricane deck. The cargo ports are twelve in number, eight between the main and hurricane decks and four between the lower and main decks. They are evenly distributed forward and aft on each side. For the handling of the cargo two steel pole masts are fitted, each with 8-ton booms, four on the foremast and two on the mainmast. In addition, the foremast has a special boom of 30 tons capacity for the handling of heavy items. Three double-drum winches serve the foremast, while one looks after the needs of the mainmast. The winch for the 30-ton boom is 10 by 12 inches; the three others are each 8 by 8 inches.

The rudder is of the single-plate type, 1 inch thick, with a cast-steel frame; it has a wrought-iron stock 10 inches in diameter, and is hung on five pintles 5 inches in diameter, with brass sleeves. The stern frame is a steel casting. Each shaft is supported by two cast-steel struts.

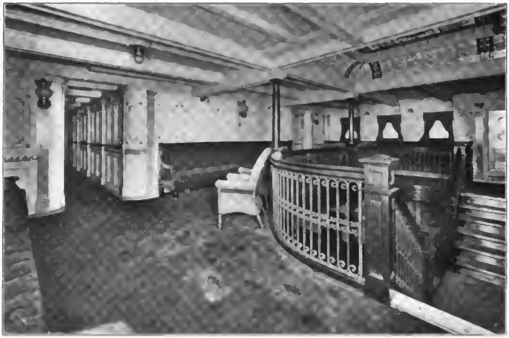
PROPELLING MACHINERY.

There are two three-bladed propellers, built up, with a cast-iron hub and manganese bronze blades. Each has a diameter of 15 feet with a pitch of 19 feet, the pitch ratio being 1.267.

MAIN STAIRCASE. STATEROOM SUITE.
STEERAGE DINING HALL. STEERAGE LOUNGING ROOM.

Each propeller is operated by a four-cylinder quadruple expansion engine (both in a broad engine room without divisional bulkheads), with cylinders 23, 33½, 48½ and 70 inches in diameter and a common stroke of 51 inches. These cylinders are arranged with high-pressure forward and the others in regular rotation. All but the low-pressure are fitted with cast-iron liners. The valves are all forward of their respective cylinders, and, except for the low pressure, are piston valves, one being fitted to the high pressure and two to each intermediate. The low-pressure cylinder has a double-ported slide valve fitted with a Lovekin assistant cylinder. All valves have balanced pistons. Stephenson valve gear is fitted, with cast-iron eccentrics, cast-steel straps and forged steel rods and stems. The links are of the double bar type and forged steel; the link block is wrought steel. The exhaust through the low-pressure ports is at about 9,000 feet per minute.

All cylinders have clearances of ½ inch at the top and ⅝ inch at the bottom. The two smaller cylinders of each engine have cast-iron pistons; the other pistons are cast steel. All pistons are fitted with Ramsbottom rings of hard cast iron. The piston rods and connecting rods are of forged steel, the latter being 115 inches between centers. The cross-heads, of



GENERAL VIEW OF THE SOCIAL HALL OR LOUNGE ON THE BRAZOS.

forged steel, have double cross-head bearings. The slippers are cast iron, lined with Parsons white metal.

The reversing gear is of the all-round type with two cylinders at 90 degrees. The turning gear consists of a worm, shaft and a clutch for connection with the reversing engine. The frame is of cast-iron box section for both front and back. The bed-plate is cast iron of a strong box form. The crank shaft in each engine is of two sections built up. The thrust shaft and bearings are of the horseshoe type, with cast-iron body and twelve cast-iron collars or shoes, lined with white metal. The stern tubes are of cast iron with composition bushings; the inboard ends are fitted with composition stuffing boxes.

The engine room extends the full width of the vessel up to the lower deck. Above this, casings extend to the boat deck, where a large skylight is fitted. There are two tunnels for the shafts, and a recess in the after engine room bulkhead for the thrust bearings. This recess, which extends to the lower deck, is fitted with a flat above the thrust bearings, on which are located the electric lighting plant and engineers' work shop.

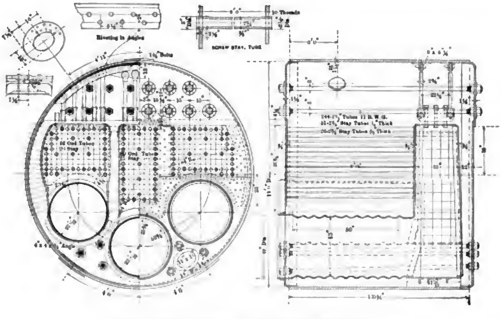
THE SMOKING ROOM ON THE MALLORY LINER BRAZOS.

FIRST CLASS DINING-ROOM ON THE BRAZOS.

BOILERS.

There are eight single-ended return tube Scotch boilers in two stokeholds, located with their grates forward and aft, and one donkey boiler between the uptakes. The main boilers are 14 feet in diameter and 11 feet 9 inches long over heads. Each has three Morison suspension furnaces fitted with Silley patent smoke-box doors. The grate bars are 5 feet 6 inches long. Each furnace has an independent combustion chamber. The total water heating surface is 18,000 square feet, and 4,000 square feet of superheating surface is fitted at the base of the uptake. The grate area is 472 square feet. The ratio of water heating surface to grate is 38.2 to 1; of total heating surface to grate, 46.6 to 1. The working steam pressure is 215 pounds. The exhaust gases and products of combustion pass from the boilers through the superheaters, and then through a nest of air tubes installed for providing hot draft on Howden's system. The two (Foster) superheaters were provided by the Power Specialty Company, New York.

The boiler shells are 1 33/64 inches thick; the back end of combustion chamber, 9/16 inch; back tube sheet, 3/4 inch; both heads, 3/4 inch. The tubes are 8 feet long, with an outside diameter of 2 1/4 inches. Each furnace has an inside diameter of 43 inches and a thickness of 21/32 inch. The longitudinal laps of the shell are fitted with double butt straps, treble riveted on each side of the butt. The donkey boiler is vertical, 6 feet diameter and 11 feet 7 inches high. The boilers are lagged with 3 inches of magnesia block, containing 85 percent of pure magnesia. Two funnels are fitted, one to each battery of boilers, and measuring 90 feet high from the base line. Wing bunkers stretch the entire length of boiler space on



STEAM IS FURNISHED BY EIGHT SINGLE-ENDED SCOTCH BOILERS.

each side of the ship, while a cross bunker is fitted forward of the forward boilers. These bunkers are fitted with ventilators, 18 inches in diameter, while the boiler and engine rooms have larger ventilators with large cowls.

AUXILIARIES.

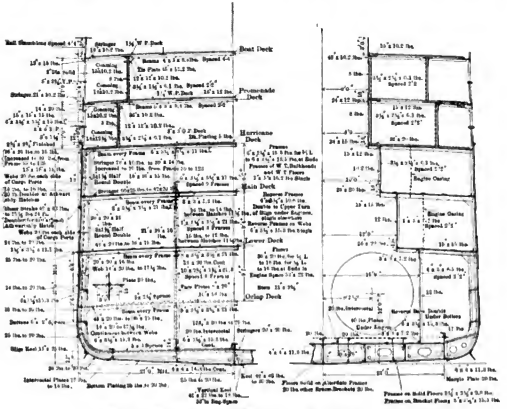
The two main condensers are independent, and are fitted with steel plate shells. They are located in the wings outboard of the main engine. Each has a cooling area of about 5,000 square feet. The auxiliary condenser, with 600 square feet of cooling area, has a cast-iron shell. In both cases the tubes are ¾ inch in diameter. Each main condenser is served by an air pump of the twin-beam independent single-acting type, with cylinders 10 and 22 inches in diameter and a stroke of 18 inches. The two circulating pumps are single-acting centrifugal, with independent engines.

Of the other pumps, all are simplex, and manufactured by M. T. Davidson Company, New York, with the exception of one reserve main feed pump of the Blake duplex type. The main feed is a vertical independent pump, 16 and 10 by 18 inches. Two other pumps of this same size are fitted, one for fire and ash ejector purposes and the other for fire and auxiliary feed. The sanitary pump measures 8 and 8 by 8 inches, and is vertical. Two independent fire pumps are fitted, 8 and 6 by 8 inches. A bilge and fresh-water pump, 4 and 4 by 6 inches, vertical; a donkey boiler feed pump, 12 and 6 by 8 inches, and a combined air and circulating pump for the auxiliary condenser, 8 and 12 by 12 inches, horizontal simplex, complete the list. There is one Reilly feed-water heater, and there are two forced draft fans. The latter are direct connected, with cranks inclosed and running in oil. They were furnished by B. F. Sturtevant Company, Hyde Park, Mass.

Other auxiliaries include two 25-kilowatt Sturtevant electric light engines and generators, each with a cylinder 9 inches in diameter by 8 inches stroke. These run at 350 revolutions per minute, and furnish direct current at a pressure of 115 volts, the maximum load being 217 amperes. The total number of 16-candlepower electric lights installed is about 600; in addition an 18-inch searchlight of 8,000 candlepower is fitted.

The windlass (forward) and two steam capstans (aft) are from the Hyde Windlass Company, Bath, Me. The cargo-hoisting winches were furnished by Williamson Bros. Company, Philadelphia. The steam steering gear was built by the Hyde Windlass Company, and includes a Brown telemotor. The steering gear is fitted right aft, and is of the usual right and left-handed screw gear type. Cast-steel stockless anchors of the Boldt type are fitted. The De Forest system of wireless telegraphy is used, operated from a room on the after promenade deck.

A 60-mile trial trip on the run from the builders' yard to New York was made at a mean draft of about 17 feet. With the engines in full gear and running at about 100 revolutions per minute, the horsepower figured out at about 6,600, and the speed at just over 17 knots. The engines have been so well balanced that during this trial trip the vibration was very slight indeed.



MIDSHIP SECTION AND SECTION THROUGH THE BOILER SPACE SHOWING SCANTLINGS.

PASSENGER ACCOMMODATIONS.

All first class passenger accommodations are located amidships. There are twenty-eight staterooms on the hurricane deck, and seventeen staterooms and six special rooms on the promenade deck. Four of these special rooms are arranged across the forward end of the promenade deckhouse, and are each fitted with brass beds and mahogany dressers. Special combined air ports and ventilators are fitted to these rooms. Two special rooms, with private baths attached, are fitted well forward in the promenade deckhouse, one on each side. Brass beds and mahogany dressers are fitted in these rooms also. In all the staterooms folding metal berths are fitted, and also

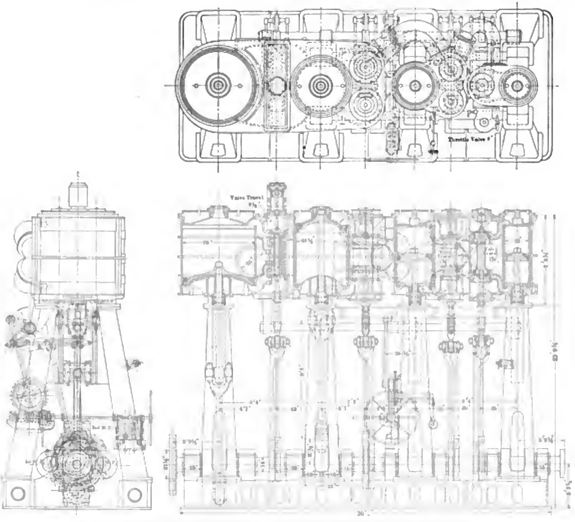
full-length transoms, upholstered in mohair plush, which can be used for berths when occasion demands. Access to all staterooms is from inside passages or from alcoves, there being a continuous fore-and-aft passage on each side in both deckhouses. Divisional bulkheads between staterooms are double in all cases.

The main dining saloon, located in the forward end of the hurricane deck house, is paneled in quartered oak, and is lighted by 20-inch brass air ports, the latter being fitted with inside blinds. In addition a large skylight, with leaded glass dome below, provides light for the dining room and for the interior of the promenade deckhouse. The dining room has a seating capacity for 104 persons.

First class toilet spaces are located between boiler casings on both the hurricane and promenade decks. The decks in these spaces are covered with mosaic tiling, and a tiled wainscoting is fitted all around. Two bath rooms are fitted on each of these decks. The plumbing was furnished by McCambridge & Company, Philadelphia.

The passages and all promenade spaces in the first class passenger quarters on the hurricane deck are paneled in white pine; on the promenade deck composite board with composite ornaments has been used.

Accommodations for the second class passengers are provided in two tiers of steel houses aft. There are thirty-four staterooms, each fitted with three metal berths. There is a



THERE ARE TWO MAIN ENGINES OF THE VERTICAL, FOUR CYLINDER, QUADRUPLE EXPANSION TYPE.

large dining room extending the full width of the deck house, and a second class galley aft, fitted with steam kettles, etc.

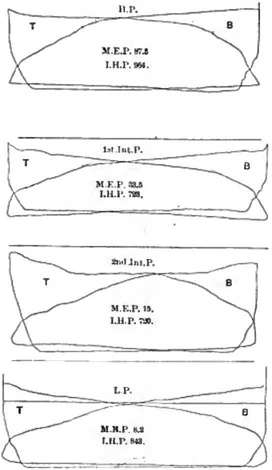
Several social halls are fitted in the first class accommodations, the principal one being located just forward of the engine casing, where is located the main stairway between the hurricane and promenade decks. This stairway is of mahogany, with metal grills and mahogany top rail. It is lighted through a large skylight with a leaded glass dome below. Writing desks and settees are fitted in the promenade deckhouse in the neighborhood of the light well to the dining room.

The first class smoking room is located in the after end of the promenade deckhouse, and is paneled in quartered oak. All upholstery in this room is leather of a light tan color. A private inclosed stairway leads from the hurricane deck directly into the smoking room.

In the steel house on the boat deck are fitted the captain's stateroom and bath, captain's office, three staterooms for deck officers and an officers' bath room. The captain's quarters are finished in quartered oak. Rooms for the chief engineer and first assistant engineer are located in the promenade deck house opposite the engine casing, to which they have direct access. The chief engineer's room has a private bath attached. Quarters for the engineers, firemen, cooks, waiters, etc., are on the main deck abreast the machinery casing. These quarters are all inclosed with steel bulkheads, and all are fitted with metal berths. Separate mess rooms for engi-

neers and for deck officers are provided. Engineers' toilets and bath, firemen's toilet and showers, and waiters' toilets and showers are located on the main deck in the boiler inclosure. The quartermasters' and seamen's quarters are located on the main deck forward.

The first class galley is located on the main deck forward of the forward boiler casing, and is fitted with all conveniences in use on modern high-class passenger steamers. There is a special inclosure for the bakery. A large ice house, with butcher shop attached, is provided at the sides of the vessel on each side of the galley, and port doors are fitted in the side of the vessel, convenient for filling the ice house and for placing supplies on board. The first class pantry is located on the hurricane deck aft of the dining room, to which it is direct connected by two sets of double doors. It is directly over the galley, to which access is obtained by a stairway fitted in the same inclosure; and a dumb waiter is fitted for conveying food from the galley direct. The pantry outfit includes an 11-foot steam table, urns, egg boiler, etc.

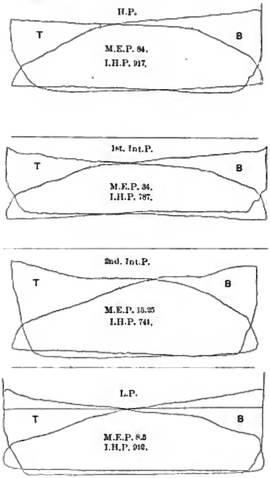


INDICATOR CARDS FROM PORT ENGINE.

During the first round trip between New York and Galveston opportunity was afforded for observing carefully the operation of all the machinery, and for obtaining service trial results. The indicator cards shown were taken October 7, with boiler gage 215 pounds, and a vacuum of 26 inches. The starboard engine, running at 102 revolutions per minute, showed an indicated horsepower of 3,357. The port engine, running at 103 revolutions per minute, showed an indicated horsepower of 3,250. The aggregate was 6,607 indicated horsepower, to which may be added 450 horsepower, assumed for the auxiliaries (see below), making a total of 7,057 horsepower. The indicator cards were taken with springs, measuring, respectively, 100 pounds per inch for the high pressure and 50, 16 and 10 pounds for the other three cylinders, respectively. They were taken under average full-power conditions, and may be said to be fairly representative. The mean effective pressure, referred to the low-pressure cylinder, was 32.67 pounds per square inch starboard and 32.52 pounds port.

The auxiliaries in service, and the estimated horsepower each, are tabulated:

	Horsepower.
Two circulating pumps	194
Two air pumps	41
One feed pump	31
Two blower engines	140
One dynamo engine	41
One sanitary pump	3
Total	450



INDICATOR CARDS FROM STARBOARD ENGINE.

In addition, there were occasionally in service a bilge pump, a fresh-water pump, an ash ejector pump and the steering engine. Some of these, however, were used not more than one hour per day, and their total horsepower may safely be assumed as about 20, making the total estimated horsepower of the auxiliaries about 470.

In computing the coal burned per horsepower per hour, a number of bags of coal were carefully weighed, and in each watch the total number of bags used was carefully recorded. Data obtained in this way, after taking account of the amount of coal put into the ship at New York, and the assumed consumption in port at both places, checked within 5 tons of the bunker measurement on the completion of the round trip. Without going into details in this regard it was estimated that the ship left New York with 1,275 tons in her bunkers.

She burned 520 tons in four and three-quarter days (109 tons per day) when runing at maximum full power to Galveston. Sixty tons were used in port in Galveston, and 450 tons for the return run, which was made under easy conditions.

A number of tests of considerable duration were run, which are given in abstract in the appended table. The mean draft of the ship on leaving port was 20 feet 4½ inches, corresponding with a displacement of about 8,200 tons. The draft on each of these tests was not noted, but must have been less, on account of the continual consumption of coal.

The first test, marked A, was run under full power under natural conditions, with all eight boilers in use, and with the engines in full gear. The second test, marked B, was run under the same conditions as the first. The third test, marked C, was run with six boilers operated at full power, and with the engines in full gear practically all the time. The last test, marked D, was run with six boilers; but the blowers and furnace pressure were cut down somewhat. The engines were linked up, the starboard high pressure 3½ inches, and low pressure 1½ inches; the port, ¼ inch less in each case; the intermediate cylinders were in full gear.

	A.	B.	C.	D.
Duration of trial, hours......	24	16	40	12
Average speed through the water, knots	16.27	16.39	15.71	15.27
Average revolutions per minute	98.9	99.6	95.44	92.8
Indicated horsepower, main engines	6291.	6400.	5744.	5372.
Coal per 24 hours, tons.....	90.14	95.9	80.57	79.81
Coal per I. H. P. per hour, main engines, pounds......	1.337	1.298	1.354	1.37
Coal per I. H. P. per hour, main and auxiliary engines, pounds	1.244	1.303	1.210	1.292

The results, as shown in the consumption of coal per indicated horsepower per hour, are especially fine, the figures given indicating that in no case did the total consumption, based on main engine horsepower alone, exceed 1.4 pounds, while if we include the 470 horsepower of auxiliaries (420 horsepower in the last case) the results are shown to be even better. The slip of the propellers, on a run of 695 nautical miles from Galveston to Dry Tortugas in slack water, and at a mean speed of 16 knots, was found to be 12.2 percent.

MARINE ENGINE DESIGN.

BY EDWARD M. BRAGG, S. B.

Engine Bed.—The stresses to which the engine bed will be subjected are very hard to calculate accurately, as they depend upon the alinement, balance, etc. The thickness of metal necessary for a rigid bed is determined more by experience, and is usually from ⅞ inch to 1½ inches when the bed is of cast iron, and from ¾ inch to 1¼ inches when of cast steel. When made of cast iron, the longitudinal girders and cross girders carrying the main bearings are made of the hollow box form (see Fig. 36), usually open at the bottom, with flanges for the holding-down bolts. When made of cast steel, it is found best to make all parts of the open *I* section, a section consisting of a central web with broad flanges at the top and bottom. (See Figs. 37 and 38.)

The bed is usually made in sections, to facilitate casting and handling, the break in the bed usually coming opposite the coupling flanges of the shaft. The cross girders can be figured as beams supported at the center line of the longitudinal girders, and loaded in the center of their length with the load for which the bearing caps are figured. The width of the cross girders is less than the length of the bearings which they carry, the amount of the overhang of the bearings being about three-fourths of the overhang of the boxes of the crank-pin end of the connecting rod. The sectional area of the cross girder under the bearing should be sufficient to keep the

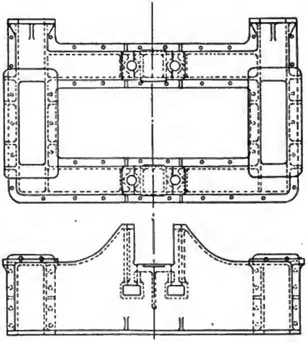


FIG. 36.

stress from 600 pounds to 1,000 pounds per square inch for cast iron, and from 1,000 pounds to 1,500 pounds for cast steel. As the after bearing is subjected to the greatest load, the girder carrying it should be figured, and the depth of the other girders taken from this. This depth will be the minimum depth; that taken finally may be such as will cause the connecting rod to clear the sole plate at the bottom of the stroke.

The distance between the two longitudinal girders should be sufficient to clear the connecting rod as it rotates. To do

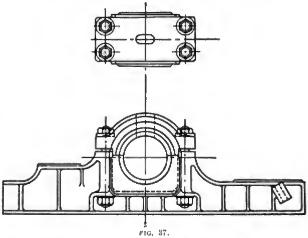


FIG. 37.

this it is best to draw a clearance diagram for the crank-pin end of the connecting rod, showing the path of the extreme points. The side girders should then clear this path by 1 inch to 2 inches. Usually the cross girders are carried from 1½ to 2 inches below the lowest point of the clearance diagram, otherwise the sole plate must be cut away at the crank pits to clear the connecting rod.

Main Bearing Caps.—The main bearing caps are made of cast iron, cast steel, wrought steel or bronze. When made of wrought steel, the brasses are flat backed, as shown in Fig. 39. When made of cast iron, cast steel or bronze, they

are of the shape shown in Fig. 37, and the white metal is put into recesses cored out in the cap. The caps are always provided with hand holes, by means of which the temperature of the shaft can be ascertained; they are also used for applying grease to the shaft. The hand holes are 2½ inches wide and 4½ or 5 inches long, the narrower dimensions being in the direction of the center line of the shaft. The width of the cap will be the same as that of the cross girder carrying the bearing, or from 1 inch to 3½ inches less than the length of the bearing. The load to be used in figuring the bolts and cap should be the maximum upward load coming upon the cap. In the after bearings of the different cylinders the greater loads act upon the top and bottom of the bearings, while in the forward bearings they act upon the sides of the bearings. Caps will be figured, however, as if the maximum loads acted upon the tops of all the bearings. The following factor, applied to the mean loads obtained from formula 44, will give the maximum loads coming upon the bearing caps:

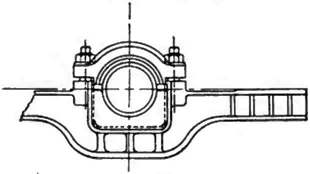


FIG. 38.

Cylinder.	Type of Engine.	Which Bearing.	Factor.
1st	All	Forward and after	2.
2d	Triple	Forward and after	1.75
2d and 3d	Quadruple	Forward and after	1.75
3d	Triple	Forward	1.67
4th	Quadruple	Forward	1.67
3d	Triple	After	1.4
4th	Quadruple	After	1.4

The size of the bolts to carry these loads can be taken from Table IV. The number of bolts in the caps depends upon the construction of the bed. If the bed is of cast iron, two bolts are usually put into each bearing to hold down the cap (see Fig. 36), unless the cap is long, when four bolts will be used. If the bed is made of cast steel, and the cross girders are of the open I section, four bolts are commonly used in order to clear the central web (see Fig. 37). Sometimes a boss is cast in the central web, and two collar studs used, as shown in Fig. 38. When the construction shown in Fig. 36 is used, the studs can be placed close to the shaft, allowing a clearance of ½ to ¾ inch. When the construction is as shown in Figs. 37 and 38, the clearance will be much more.

The caps should be figured as beams supported at the ends and the load distributed over a part of the length. Using the maximum load for which the bolts were designed, the bending moment will be $\frac{Wl}{6}$, where W = load and l = distance between the center lines of the bolts. In obtaining the moment of inertia of the section of the cap, the breadth to be used should be the breadth of the cap minus the breadth of the hand hole, usually 2½ inches.

The height of the cap will be:

$$H = \sqrt{\frac{Wl}{fB}}, \qquad (45)$$

where W = the maximum load upon the cap;
l = the distance between the center lines of bolts;
B = the net breadth of cap;
and f = such a stress as will give a factor of safety of 10, since the caps may be subjected to pounding.

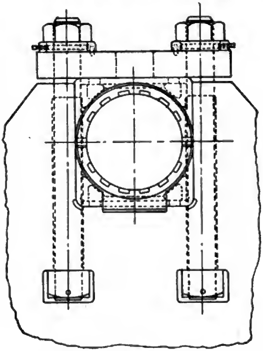


FIG. 39.

If the top of the cap is cored out, the formula

$$\frac{BH^3 - bh^3}{12}$$

should be used in getting the moment of inertia of the section,

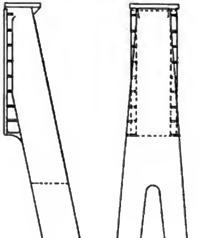


FIG. 40.

where b is the breadth and h is the height of the cored space. In this case the cap will be figured from the formula:

$$f = \frac{WlH}{BH^3 - bh^3} \qquad (46)$$

ENGINE FRAME.

The engine framing is made of cast iron, cast steel and wrought steel. When made of cast iron, the framing usually consists of hollow inverted Y-shaped supports (see Fig. 40), sometimes called housings, carrying the guide surface for the slipper. When made of cast steel, they sometimes have the same shape as the cast-iron housings, but are made in two parts joined together by a vertical flange (see Fig. 41). The other form in which cast steel is used for engine framing is shown in Fig. 42. These columns are very often used upon the front of the engine, two to each cylinder, in order that access may be had to the crank shaft. When a cross head of the type shown in Fig. 20 is used, four of these columns are used for each cylinder, with a narrow guide surface upon each column. Cylindrical columns of wrought steel are also used, as shown in Fig. 43. When the framing is of wrought steel it consists of cylindrical columns tied and braced longitudinally and athwartship to make the framing rigid (see Fig. 44).

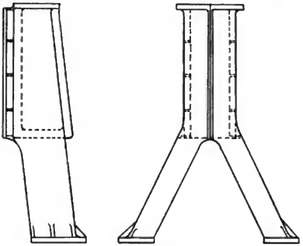


FIG. 41.

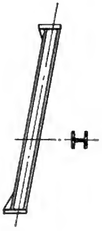


FIG. 42.

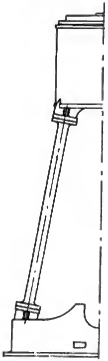


FIG. 43.

The framing may consist of housings on both front and back of engine, of housings on the back and columns on the front, of cast steel columns on both front and back of engine, or of steel framing. When housings are used, they should be designed to have sufficient area in the smallest section to carry the maximum load coming upon the piston rod, with a stress of 600 to 1,000 pounds for cast iron, and 1,000 to 1,500 pounds for cast steel. The shape of the cross section of the housings will be determined by the size of the slipper guide, and the shape of the flange at the top necessary to accommodate the number of bolts needed to carry one-half of the load on the piston rod.

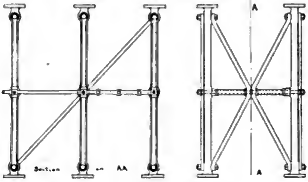


FIG. 44.

The columns can be figured by formulæ 21 and 22, given for piston rods. The character of the load is alternating, so that a factor of safety of 12 should be used. Since its length will be considerably greater than that of the piston rod, and its load only one-half of that, its diameter generally comes about the same as that of the piston rod. The column is very often made hollow, to save weight. Whenever it can be arranged, cross-ties are carried from the top of the housing to the foot of the columns, so as to give the housing additional stiffness. When the framing is made entirely of steel columns and ties the stresses are determined by means of a graphical analysis.

Calculations.—The diameter of the crank shaft and diameter and length of the crank pin have already been determined.

$$D = 12 \text{ inches;}$$
$$C = 12.5 \text{ inches;}$$
$$B = 14'' + 0.25'' = 14\tfrac{1}{4} \text{ inches.}$$

The crank shaft will be made built up, in three interchangeable sections.

$$A = 0.65 \times 12 = 7.8 \text{ inches (use 8 inches);}$$
$$E = 0.28 \times 12 = 3.36 \text{ inches (use } 3\tfrac{3}{8} \text{ inches);}$$
$$F = 0.25 \text{ inches;}$$
$$J = 2 \text{ inches;}$$
$$K = 12.75 \text{ inches;}$$
$$L = 13 \text{ inches;}$$
$$M = 11.375 \text{ inches;}$$
$$N = 12 \text{ inches.}$$

Assume radius of pitch circle of coupling bolts $= 12'' \times 0.75 = 9'' = r$.

Assume n to be 6.

Formula (43): $$R = \frac{12}{2}\sqrt{\frac{12}{6 \times 9}} = 2.83 \text{ inches.}$$

Let the taper of the bolt be 1 inch per foot, and the length of bolt = 6½ inches, the large end projecting ¼ inch beyond the flange.

Diameter of bolt at large end

$$= 2.83 + \frac{3.5}{12} = 3.122, \text{ (use } 3\tfrac{1}{8} \text{ inches).}$$

The smaller end of the taper will be

$$3.125'' - \frac{6.5}{12} = 2.583 \text{ inches diameter.}$$

The threaded part on the end can be made 2¼ inches diameter.

A 2¼-inch nut is about 4 inches across the angles, so the pitch circle of the coupling bolts must be at least 2 inches from the outside of the shaft; 9 inches — (6 inches + 2 inches) = 1 inch clearance between nut and shaft. This can be made less if necessary. Try $r = 8.625$ (formula 42).

$$R = \frac{12}{2}\sqrt{\frac{12}{6 \times 8.625}} = 2.89 \text{ inches;}$$

$$2.89 + \frac{3.5}{12} = 3.182'', \text{ (use } 3\tfrac{1}{4} \text{ inches).}$$

$$\text{Diameter at smaller end of taper} = 3.25 - \frac{6.5}{12} = 2.708 \text{ inches.}$$

The diameter of threaded part can be 2½ inches. The nut will be about 4½ inches across angles; 8.625 — (6 + 2.25) = 0.375 inch clearance between nut and shaft. Diameter of flange = 2(8.625 + 3) = 23.25 inches.

Loads Upon Bearings.—Values of f from Fig. 31 for 3,000 *I. H. P.*, built-up shaft, give the following loads upon the main bearings:

First cylinder, forward

$$L = \frac{21,000}{850} \times 0.77 \times 1,000 = 19,000 \text{ pounds.}$$

First cylinder, aft

$$L = \frac{21,000}{850} \times 0.77 \times 1,000 = 19,000 \text{ pounds.}$$

Second cylinder, forward

$$L = \frac{21,000}{850}(1,000 + 0.11 \times 1,000) = 27,400 \text{ pounds.}$$

Second cylinder, aft

$$L = \frac{21,000}{850}(1,000 + 0.61 \times 1,000) = 39,800 \text{ pounds.}$$

Third cylinder, forward

$$L = \frac{21,000}{850}(2,000 - 0.14 \times 1,000) = 46,000 \text{ pounds.}$$

Third cylinder, aft

$$L = \frac{21,000}{850}(2,000 + 0.64 \times 1,000) = 65,200 \text{ pounds.}$$

Area for each high-pressure bearing

$$= \frac{19,000}{200} = 95 \text{ square inches,} \quad \frac{95}{12} = 7.92''$$

Area for second cylinder, forward

$$= \frac{27,400}{250} = 110 \text{ square inches} \quad \frac{110}{12} = 9.16''$$

use 9 inches.

Area for second cylinder, aft

$$= \frac{39,800}{275} = 145 \text{ square inches} \quad \frac{145}{12} = 12.1''$$

Area for third cylinder, forward

$$= \frac{46,000}{300} = 153.5 \text{ square inches} \quad \frac{153.5}{12} = 12.8''$$

use 12⅞ inches.

Area for third cylinder, aft

$$= \frac{65,200}{350} = 187 \text{ square inches} \quad \frac{187}{12} = 15.58'' \text{ use } 15\tfrac{5}{8} \text{ inches.}$$

See Fig. 46 for sketch of the three sections of shafting.

Loads for which main bearing caps and bolts are to be figured are:

High-pressure bearings, $19,000 \times 2 = 38,000$
Medium-pressure forward bearings, $27,400 \times 1.75 = 47,900$
use 48,000 pounds.

Medium-pressure after bearings, $39,800 \times 1.75 = 69,700$
Low-pressure forward bearing, $46,000 \times 1.67 = 76,800$
use 75,000 pounds.

Low-pressure after bearing, $65,200 \times 1.4 = 91,250$ pounds.

Main bearing bolts for 48,000-pound load must be two of 2¾ inches.
Main bearing bolts for 75,000-pound load must be two of 3¼ inches.
Main bearing bolts for 91,250-pound load must be two of 3½ inches.

Make lower brass "half-round" with a thickness of $\frac{D}{10} +$ 0.25 inch = 1.2 inches + .25 inch = 1.45 inches (use 1½ inches). Bolts will clear shaft by 2½ inches to allow for the brass and the metal of the bed.

Distance between centers of 2¾-inch bolts
$= 12'' + 5'' + 2.75'' = 19.75$ inches.

Distance between centers of 3¼-inch bolts
$= 12'' + 5'' + 3.25'' = 20.25$ inches.

Distance between centers of 3½-inch bolts
$= 12'' + 5'' + 3.5'' = 20.5$ inches.

Handholes in main bearing caps to be 2½ inches wide.

$$\text{Caps to be of cast steel, and stress to be } \frac{60,000}{10} = 6,000 \text{ pounds.}$$

Caps for high-pressure and forward medium-pressure bearings:
Formula (45):

$$H = \sqrt{\frac{48,000 \times 19.75}{5.5 \times 6,000}} = 5.36 \text{ inches.}$$

Caps for after medium-pressure and forward low-pressure bearings:

$$H = \sqrt{\frac{75,000 \times 20.25}{8.5 \times 6,000}} = 5.47 \text{ inches.}$$

Caps for after low-pressure bearing:

$$H = \sqrt{\frac{91,250 \times 20.5}{10.5 \times 6,000}} = 5.45 \text{ inches.}$$

Make all of the caps 5½ inches thick from the back of the white metal, or 6 inches thick, allowing for the white metal.

(To be continued.)

Revision of the United States Laws Relating to the Safety of Life at Sea.

President Roosevelt has recently appointed a commission for the revision of laws relating to the safety of life at sea. One of the most important duties of this commission lies in a careful revision of the laws which relate to the construction and inspection of steam boilers. The rules at present in force are very much out of date, and need thorough revision to meet the requirements covering the best materials and best methods of modern practice in construction; expert inspection in materials, design and workmanship; conformation of the United States rules with the requirements of marine insurance companies; and adequate provision for conditions on the Great Lakes and Mississippi River with its tributaries.

DESCRIPTION OF A 140-TON FLOATING CRANE WITH A TEST CAPACITY FOR LIFTING 200 TONS.

BY H. PRIME KIEFFER.

Practically up to the present time, shear-leg construction has been exclusively employed for floating cranes. With this system the feet of the forelegs lie at the pontoon gunwale and the load must be passed between the legs, an arrangement which has a number of striking disadvantages. In the first

FIG. 1.—140-TON FLOATING CRANE PLACING BOILERS ABOARD THE MAURETANIA.

place the loads to be handled must not exceed certain dimensions, limited, of course, by the sloping position of the fore shear-legs. Secondly, the outreach of the crane from the turning point of the legs to the middle of the hook cannot be used to its full extent, for even at a small inclination the legs will be in touch with the side of high ships. (See Figure 2). Finally, the legs are clumsy and expensive, owing to their length.

These drawbacks are entirely overcome by a new and interesting type of floating crane built by the Duisburger Machinenbau, A. G., formerly Bechem & Keetman, of Duisburg, Germany. The general appearance of this new crane can best

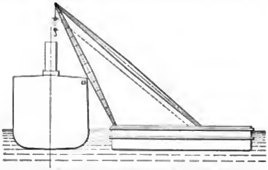


FIG. 2.—ILLUSTRATING THE DRAWBACKS OF A SHEAR-LEG CRANE.

be gained by a glance at the illustrations shown in connection with this article.

In this new construction the turning points of the jib are kept so far back from the pontoon gunwale that sufficient space is left in front of them for taking up the materials to be handled. Thus the latter need no longer be passed between the crane legs, and may, therefore, have any dimensions. Masts, stacks, boilers and other long and cumbersome parts of a vessel may easily be fitted with the help of a crane of this new construction, while this work becomes rather difficult, and very often impossible, when the usual shear-leg crane is employed. By withdrawing the turning point from the foot of the jib we further attain the advantage that the legs do not come into contact with the vessel's side. The crane barge can lie close alongside of the ship, and the jib, as far as the screw spindles permit, may be adjusted towards the outside.

From the constructional point of view this type of crane has the further advantage that the whole jib can be of lattice work, and thus it is of a relatively small weight. In addition to this, the principal parts of the jib can, if desired, take an angular shape and need no longer be led in a straight line.

Several cranes of this type, with a capacity of 100 tons, have

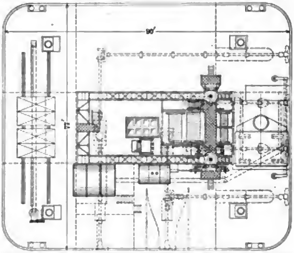


FIG. 3.—PLAN VIEW OF PONTOON, SHOWING LOCATION OF PROPELLING MACHINERY.

been built by the Duisburger Machinenbau, A. G., but not until comparatively recently did they attempt one so large as 140 tons with a test of 200 tons. When Messrs. Swan, Hunter, Wigham and Richardson took the contract to build the mammoth Cunard Liner "*Mauretania*," they realized that the fitting out of the ship would present some serious difficulties, if done by old methods, as some of the equipment, notably the boilers, was very large and heavy. They therefore ordered a crane of the new type with a capacity of 140 tons, which was considered at the time rather high, as such a great capacity had

never before been attempted when building a floating crane.

It must be pointed out that a serious restriction as regards the structure of the crane was imposed upon the constructors on account of the bridge situated near Elswick-on-Tyne. The lower flange of the bridge is in spring tide only about 85 feet above the surface of the water. The crane, however, when erected, has a height of 131 feet, and consequently it was necessary to provide a lowering arrangement, so that the crane could pass underneath this bridge. The jib is therefore swung around two fore foot points and is adjusted by means of two spindles of Siemens-Martin steel. Water ballast serves as a counter weight, the water being placed in two water-tight compartments of the pontoon. The large boiler for the engine also serves as a counterweight.

The square pontoon has a size of 90 feet by 77 feet and a height of 13 feet 10 inches. The corners are rounded. When 140 tons are on board and the load is suspended at the hook,

iron. The drums run loosely on axles of 5½ inches diameter. All spur wheels are made of the best steel.

The drums for the 20-ton winch have the same length and are built similarly to the large drums, but with a diameter of only 2 feet 9 inches. A special steam twin engine of 40 horsepower serves for setting the 5-ton winch in motion. This winch has two drums, one to take up the lifting rope and the other one to take up the traveling rope, which sets the trolley, running along the lower flange of the upper part of the jib, in motion.

The following speeds can be obtained:

In lifting a load of 140 tons at the 140-ton hook, about 3 feet 10 inches per minute.

In lifting a load of 70 tons at the 140-ton hook, about 8 feet 2 inches per minute.

In lifting a load of 20 tons at the 20-ton hook, about 26 feet per minute.

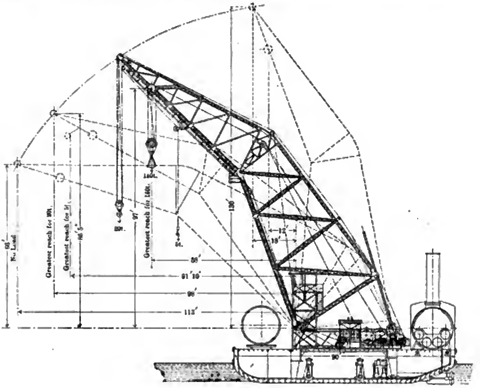


FIG. 4.—SECTIONAL VIEW OF 140-TON FLOATING CRANE.

the draft is 8 feet, the inclination 6 degrees and the height from the water surface to the upper edge of the pontoon about 10 inches. Two longitudinal and two cross partitions divide the interior of the pontoon into nine compartments. The four engines are placed in the center room underneath the crane structure. Loads can be transported on the fore deck by means of several truck cars running on rails. Four steam capstans are arranged in the corners of the pontoon, which serve for hauling purposes; steam winches are also provided for the anchors.

The crane is fitted with three hooks, one each of 140, 20 and 5 tons capacity. The gearings for the various blocks are placed on deck underneath the crane structure. The large winch for the load of 140 tons has a double rope drum and is driven by a steam twin engine of 120-horsepower capacity. This engine also sets the 20-ton winch in motion, as well as the spindles for derricking the crane jib. Both drums of the large winch are built similarly; each one has a diameter of 4 feet 3 inches, a length of 8 feet 8 inches and is made of cast

In lifting a load of 10 tons at the 20-ton hook, about 53 feet per minute.

In lifting a load of 5 tons at the 5-ton hook, about 65 feet per minute.

The crab travels at the rate of about 65 feet per minute.

The general design of the 100-ton crane is about the same as that of the 140-ton structure, but the construction is not so massive. This design has also but two hooks, a main one of 100 tons and an auxiliary one up to 20 tons. The main hook of the 100-ton crane has a maximum outreach of 68 feet 8 inches, and the 20-ton hook, one of 100 feet. With a pontoon whose beam is 66 feet a free space about 24 feet 6 inches remains on deck in front of the jib, in order to ship the articles.

The crane is equipped with a two-cylinder special 9-inch crane engine, rated at about 105 horsepower. This engine drives the four lifting gears and the luffing gear; the large lifting gear is supplied with two drums, each taking one fall of the large lifting rope that carries the 100-ton hook in eight

strands; the smaller hook of 20 tons is suspended by four strands. Besides these at both sides of the framing, two lifting gearings are placed for lifting loads up to 1½ tons.

The working speeds are as follows:

Lifting loads of 100 tons with main hook, about 5 feet 4 inches per minute.

Lifting loads of 40 tons with main hook, about 10 feet 8 inches per minute.

Lifting loads of 20 tons with auxiliary hook, about 28 feet 8 inches per minute.

Lifting loads of 10 tons with auxiliary hook, about 55 feet 6 inches per minute.

Lifting loads of 1½ tons with auxiliary hook, about 90 feet 8 inches per minute.

The luffing of the jib occupies about 12 minutes.

The luffing mechanism operates as follows: At the end of the back stay of the jib two manganese-bronze nuts are inserted, which swing around two cross pinions. The long spindles are screwed into these nuts. The screws are turned with the help of a steam engine placed on deck and corresponding shafting equipped with bevel gears. In consequence the nuts at the ends of the jib, mentioned above, shift on the screws, by which means the jib is drawn in or out, according to the turning direction of the screws.

The steel structure of the crane is composed of light but strong lattice work. At the side of the framing is located the driver's cabin, from which all movements are controlled and in which all necessary hand wheels, brake levers and accessories for controlling the engines are placed.

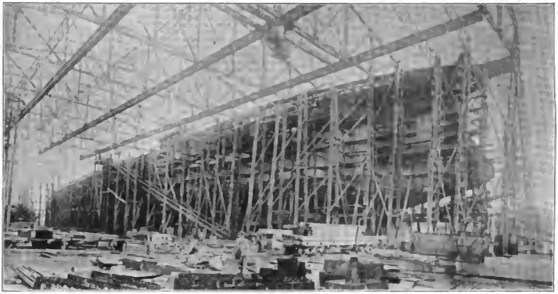
The pontoon has a length of 87 feet 6 inches, a beam of 65 feet 6 inches and a height of 9 feet 10 inches. Two screws are provided for the propulsion of the crane, each being turned by an engine of 60 horsepower. With the above-described pontoon a speed of 3 or 4 knots can be attained. On deck four spills with vertical drums are fitted, which are driven by a special small engine. Opposite the jib a water tank is provided, taking 130 tons and serving as a counterweight. For filling and emptying this tank a steam pump of 1 to 1½ cubic meters per minute capacity is installed. Two boilers are fitted, each having a length of 12 feet 10 inches and a diameter of 6 feet, with a heating surface of about 500 square feet. For ordinary work one boiler is sufficient; the second serves as a reserve and for use in case the pontoon has to travel a long distance. Some cranes of similar design have been built and equipped with gas engines and they have given good service.

THE BATTLESHIP NORTH DAKOTA IMMEDIATELY AFTER LEAVING THE WAYS.

LAUNCH OF THE NORTH DAKOTA.

On Nov. 10 the battleship *North Dakota*, the first of the American *Dreadnoughts*, was launched from the yards of the Fore River Shipbuilding Company, Quincy, Mass. The ceremony of christening the ship was performed by Miss Mary Benton, of Fargo, North Dakota.

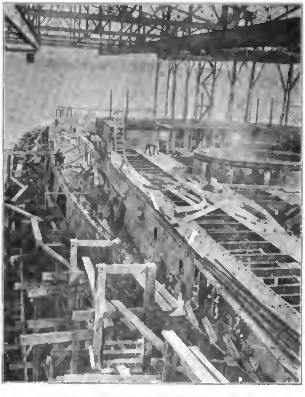
Contracts for the two battleships *North Dakota* and *Delaware*, which were authorized by the Naval Programme of 1906-1907, were awarded Aug. 6, 1907, that for the *North Dakota* being placed with the Fore River Company and that for the *Delaware* with the Newport News Shipbuilding & Dry Dock Co. The keel of the *North Dakota* was laid Dec. 16, 1907, the



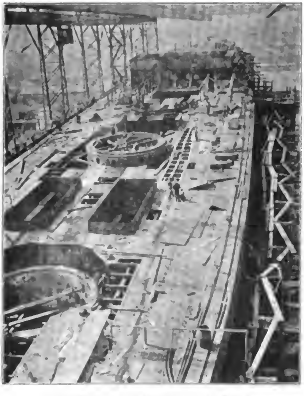
SIDE VIEW OF BATTLESHIP NORTH DAKOTA, OCT. 1, 1908, 54.2 PERCENT COMPLETED.

day on which the Atlantic fleet started on its voyage around the world. The launching was, therefore, accomplished in ten and three-quarters months, or 282 working days after the laying of the keel. This, as a record for speed in warship construction, equals, if not surpasses, the records made in other countries. In one or two instances first-class battleships have been launched in other countries in slightly over eight months, but their percentage completion at the time of launching was not as great as in the case of the *North Dakota*. When the *North Dakota* was launched she was 60 percent completed; and, in addition, much of the vessel's auxiliary machinery, fittings and equipment are already finished and ready for installation, including the five turrets for the main battery. According to the terms of the contract the ship is to be completed July 18, 1910.

The *North Dakota* is 519 feet long over all and 510 feet long on the waterline. She has a beam of 85 feet 2⅝ inches, and a draft at displacement of 20,000 tons of 26 feet 10 inches. At her full-load displacement of 2,275 tons her draft is 27 feet 3 inches. Curtis turbines of a total estimated horsepower of



VIEW OF NORTH DAKOTA, OCT. 1, LOOKING AFT.



AFTER DECK OF NORTH DAKOTA, LOOKING FORWARD.

25,000 are to drive the ship at a speed of 21 knots, steam being furnished by twelve Babcock & Wilcox watertube boilers, arranged for burning oil in addition to coal. The contract price of the hull and machinery was $4,477,000 (£920,000).

The armament of the *North Dakota* consists of ten 12-inch breechloading rifles mounted in pairs in revolving turrets on the center line of the ship. The arrangement of the turrets is such that all of the 12-inch guns can be fired on either broadside, four of them ahead and four of them astern. To make this possible, two of the turrets are so located that their guns can be fired over the adjacent turret. In addition to the main battery there is a secondary battery of fourteen 5-inch rapid-fire guns for repelling torpedo-boat attack. Ten of these guns are mounted on the gun deck, five on each side, the other four being mounted in sponsons on the gun deck at the bow and stern.

The remaining armament consists of four 3-pounder rapid-fire guns, four 1-pounder semi-automatic guns, two 3-inch

STERN VIEW OF THE NORTH DAKOTA ON THE WAYS.

field pieces, two machine guns of .30 caliber, and two 21-inch submerged torpedo tubes.

The waterline armor belt is 11 inches thick and 8 feet wide, extending 6 feet 9 inches below the full-load waterline. Above this there is a belt 10 inches thick, 7 feet 3 inches wide, and above this, extending to the main deck, the ship is protected by 5-inch armor. The upper plate is 10 feet above the normal waterline and 8 feet or more above the deep-load waterline. The 12-inch turrets are protected by 12-inch and 8-inch armor.

The *Delaware*, which is being built by the Newport News Shipbuilding & Dry-Dock Company, is a sister ship of the *North Dakota*, but she will be driven by two sets of triple-expansion reciprocating engines. Therefore, when both ships have been placed in commission another splendid opportunity will be given to test the relative merits of the old-style reciprocating engine and the leading American type of marine steam turbine. It is expected that the *Delaware* will be launched sometime in February. Both ships are to be fitted with the latest fire-control system, necessitating range-finding positions on top of two lattice-work towers. This type of tower was recently tested on the monitor *Florida*, by placing it under a fire of 6-inch shells in order to demonstrate its stability under attack.

SERVICE TEST OF THE STEAMSHIP HARVARD.*

BY PROF. C. H. PEABODY, W. S. LELAND AND H. A. EVERETT.

The attention of members is particularly called to the fact that this test was run under the conditions obtaining in actual service, no attempt having been made to approximate the ideal conditions existing on the usual trial-trip runs. The engine test began at 9 P. M., when the engine had reached full power, and was stopped at 3 A. M. as we approached Nantucket Shoals. The last reading was taken at 2.55, when the first half-speed bell sounded, and the curves exterpolated to 3 o'clock. The boiler test was begun at 7.10 P. M., and continued until 7 o'clock the next morning, the curves being exterpolated to make 12 hours.

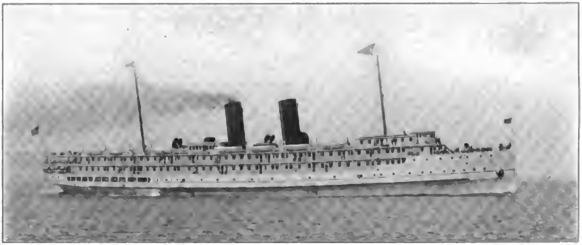
Pressures were read, as far as possible, on the engine-room gages, which were tested for the occasion by the Crosby Steam Gauge & Valve Company. Where engine-room gages were not available, Institute gages, tested at our own laboratories, were used.

The horsepower was determined by means of the Denny & Johnson torsion meter, belonging to the Department of Naval Architecture at the Institute of Technology. The inductors were so set as to give a clear length of shaft between inductors of 63.06 feet on center shaft, 47.52 feet starboard and 49.21 feet port, which gave readings of approximately 95, 75 and 70, respectively, at full power. Inductors were set on all three shafts, but during the test the port recorder failed to work at the end of two hours, due to a rupture of the connections. From the few readings thus obtained, and from readings taken on a preliminary run, when it did work satisfactorily, it appears that the torque readings on this shaft were 93 percent of those on the starboard, and in computing the horsepower this figure has been taken. This, of course, throws some little uncertainty into the calculation, but there is every reason to believe that the assumption is very nearly correct. It would take practically 3 percent error on this shaft to affect the total horsepower by so much as 1 percent. The torsion meter can be read only to single units, so that this of itself means an uncertainty in the last digit, which corresponds to an accuracy of about 1¼ percent. When, however, the readings are plotted at ten-minute intervals, as is here done, and the results faired, the probable error is likely to be much less.

In computing the horsepower 1.506 based on a torsional modulus of elasticity of 11,600,000 was used for the constant K in the formula $H.\ P. = \dfrac{K d^4 r R}{C L}$, on which d = the diameter of the shaft in inches (8 inches), r = torsion meter reading, R = revolutions per minute, C = inductor constant (12.5), L = length of shaft in feet between inductors. The shaft was not twisted to determine the exact constant, but since 11,600,000 is the mean of a large number of tests it cannot be far from right. We find 11,000,000 and 12,000,000 to be practically the minimum and maximum values, showing a variation of about 3 percent only in extreme cases. That the actual modulus of the *Harvard's* shaft should vary from the mean value by more than 1½ percent is extremely improbable. All in all, taking into account the uncertainty of the port shaft, there is every reason to believe that the horsepower is subject to an error less than that of the ordinary steam engine indicator.

* Read before the Society of Naval Architects and Marine Engineers, New York, Nov. 20, 1908.

The water consumption was measured by a 6-inch Hersey hot-water meter, loaned by the Hersey Manufacturing Company, of South Boston. It was installed in the suction line between the hot well and the feed pump, and gave exceedingly satisfactory results. This meter was previously calibrated by the Hersey Company, and indicated an under-run of 1 percent under the conditions of the test. The curve of meter readings was plotted without this correction, so that 1 percent should be added to any ordinate of that curve to get the correct reading.



TURBINE STEAMSHIP YALE, SISTER SHIP OF THE HARVARD.

Steam for all the auxiliaries excepting the blowers came through the starboard pipe only, in which a thin plate having a 2½-inch orifice was inserted. The valve on the port line was tightly closed, and the by-pass around the reducing valve on the auxiliary line opened so that all the reduction in pressure was due to the orifice. The reduced pressures were read on the auxiliary steam gage on the engine-room gage board, and the flow of steam computed from coefficients determined by experiments made at our engineering laboratories. An independent orifice was necessary for the blower engines, as this steam did not come from the auxiliary line. The curve of auxiliary steam consumption shows the total from these two orifices.

The probable error in determining the auxiliary steam is small. The gage pressures were read to the nearest pound every ten minutes, and the average must be very nearly right. An error of 1 pound in this average would mean about 2 percent error in the total auxiliary steam, but even if the error here were four times as great it would be of small moment, for the auxiliary steam is only about 13½ percent of the total.

SMOKING ROOM OF THE HARVARD.

The coal was determined by counting the buckets dumped on the floor. A curve was plotted showing the number of buckets at ten-minute intervals. Every hour the amount of unburned fuel on the floor was estimated, the corresponding points plotted, and the coal-consumption curves drawn through them. The average net weight of coal was 506 pounds per bucket. Such a method as this for coal determination is open to question, but is perhaps the best that can be adopted on a short sea run. Even had the coal been weighed, the different

condition of the fires at start and finish might have been considerable in so short a run. There is every reason to believe that any determination for so short a run would be somewhat too small. Our figures seem to show 80 tons for twelve hours, equal to 100 tons for fifteen hours, the running time from dock to dock, and this figure checks remarkably well with the amount of coal actually placed on board, an average being taken over a large number of trips.

The quality of steam was determined by the throttling calorimeter, the sample being taken from a tee on the top of the steam main, inserted for this purpose where the pipe was tapped for the gage connection.

The engine test data was plotted. For the sake of simplicity only those observations appear in the plot which vary from the curve by an amount greater than the possible accuracy of observation. The close similarity of the curves and the small number of points through which the curves do not pass, is a strong check on the accuracy of the observations.

The following tables give the summary of the results and the principal dimensions of the vessel.

DIMENSIONS.

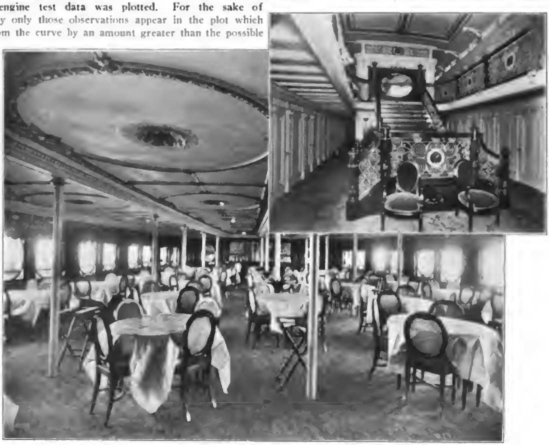
Length between perpendiculars	386 ft. 6 in.
Breadth of hull molded	50 ft. 6 in.
Breadth over guards	63 ft.
Depth molded	22 ft.
Draft normal	16 ft.
Draft at trial (mean New York to Boston)	16 ft. 2 in.

RESULTS OF BOILER TEST.

Date of test	June 25, 1908.
Duration of test	12 hours.
Boiler pressure average gage	137.8 lbs.
Quality of steam	95.9
Barometer	29.97 in.
Temperature of feed water	203.5° F.
Drfat at blowers (Howden)	1.71 in.
Number of boilers (single-ended Scotch)	12
Total grate area	756 sq. ft.
Total heating surface	29,520 sq. ft.
Ratio heating to grate area	38.6
Total coal fired in 12 hours	179,112 lbs.
Total water fed in 12 hours	2,041,710 lbs.
Equivalent evaporation from and at 212° per lb. of coal	11.2
Coal per sq. ft. grate	19.6

RESULTS OF ENGINE TEST.

Type of engine	Parsons turbine.
Duration of test	6 hours.
High-pressure gage	124.4 lbs.
Low-pressure gage, average S. & P.	21.3 lbs.
Vacuum (average S. & P.)	27.42 in.
Temperature of injection water	63.5° F.
Temperature of discharge water	107° F.
Temperature of hot well	110.8° F.
Total water per hour during test	176,010
Maximum revolutions	p. 468, c. 472, s. 472.
Minimum revolutions	p. 433, c. 444, s. 441.
Average revolutions (6 hours)	455
Maximum shaft horse-power	11,076
Minimum shaft horse-power	9,525
Average shaft horse-power (6 hours)	10,405
Steam for auxiliaries per hour	22,380 lbs.
Steam (4% priming) per shaft horse-power per hour, all purposes	16.9 lbs.
Steam (4% priming) per shaft horse-power per hour, turbines only	14.76 lbs.
B. T. U. per shaft horse-power per minute	265.9
Coal per shaft horse-power (average of 6 hrs.)	1.5 lbs.



DINING SALOON AND MAIN STAIRCASE OF THE HARVARD.

A new society, known as the Institute of Metals, recently held its first meeting at Birmingham. This society has been formed for the special investigation of non-ferrous metals and alloys.

Gasoline vs. Alcohol as Fuel for Internal-Combustion Engines.

The technologic branch of the United States Geological Survey, under the direction of Mr. J. A. Holmes, has recently completed an elaborate series of tests on the relative value of gasoline and alcohol as producers of power. The tests, over 2,000 in number, probably represent the most complete and exact investigation of the kind that has been made in any country, and includes much original research work. These tests were conducted at the fuel testing plant of the Geological Survey at Norfolk, Va., under the general charge of Prof. R. H. Fernald and the personal supervision of Mr. R. M. Strong, and show the following results in regard to the comparative fuel consumption of 73 degrees specific gravity gasoline and commercial completely denatured alcohol per unit of power.

Correspondingly well designed alcohol and gasoline engines, when running under the most advantageous conditions for each, will consume equal volumes of the fuel for which they are designed. This statement is based on the results of many tests made under the most favorable practical conditions that could be obtained for the size and type of engines and fuel used. An average of the minimum fuel consumption values thus obtained gives a like figure of eight-tenths (.8) of a pint per hour per brake-horsepower for gasoline and alcohol.

Considering that the heat value of a gallon of the denatured alcohol is only a little over six-tenths (.6) that of a gallon of the gasoline, this result of equal fuel consumption by volume for gasoline and alcohol engines probably represents the best comparative value that can be obtained for alcohol at the present time, as is also indicated by Continental practice. Though the possibility of obtaining this condition in practice here has been thoroughly demonstrated at the Government Fuel-Testing Plant, it yet remains with the engine manufacturers to make the "equal fuel consumption by volume" a commercial basis of comparison.

The gasoline engines that were used in these tests are representative of the standard American stationary engine types, rating at 10 to 15 horsepower, at speeds of from 250 to 300 revolutions per minute, while the alcohol engines were of similar construction and identical in size with the gasoline engines.

The air was not preheated for the above tests on alcohol and gasoline, and the engines were equipped with the ordinary types of constant-level, suction-lift and constant-level-pressure spray carburetors. Many special tests with air preheated to various temperatures up to 250 degrees F., and tests with special carburetors, were made, but no beneficial effects traceable to better carburation were found when the engines were handled under the special test conditions, including constant speed and best load.

The commercial completely denatured alcohol referred to is 100 parts ethyl alcohol, plus 10 parts methyl alcohol, plus one-half of one part benzol, and corresponds very closely to 94 percent by volume, or 91 percent by weight, ethyl alcohol (grain alcohol).

No detrimental effects on the cylinder walls and valves of the engines were found from the use of the above denatured alcohol.

The lowest consumption values were obtained with the highest compression that it was found practical to use; which compression for the denatured alcohol ranged from 150 to 180 pounds per square inch above atmosphere.

Eighty percent alcohol (alcohol and water) for use in engines of the present types would have to sell for at least 15 percent less per gallon than the denatured alcohol, in order to compete with it. The minimum consumption values in gallons per hour per brake-horsepower for 80 percent alcohol is approximately 17.5 percent greater than for the denatured alcohol used or for gasoline. A series of tests made with alcohol of various percentages by volume, ranging from 94 percent to 50 percent, showed that the minimum consumption values in gallons per hour per brake-horsepower increased a little more rapidly than the alcohol decreased in percentage of pure alcohol. That is, the thermal efficiency decreased with the decrease in percentage of pure alcohol. This decrease in thermal efficiency, or increase in consumption, referred to pure alcohol, is, however, comparatively slight, from 100 percent alcohol down to about 80 percent alcohol. Within these limits it may be neglected in making the calculations necessary to compare the minimum consumption values for tests with different percentages of alcohol.

The nearer the alcohol is to pure, the greater the maximum horsepower of the engine. The percent reduction in maximum horsepower for 80 percent alcohol, as compared with that for denatured alcohol used, was less than 1 percent, but the starting and regulating difficulties are appreciably increased.

With suitable compression, mixtures of gasoline and alcohol vapors (double carburetors) gave thermal efficiencies ranging between that for gasoline (maximum 22.2 percent) and that for alcohol (maximum 34.6 percent), but in no case were they higher than that for alcohol. The above thermal efficiencies are calculated from the brake-horsepower and the low calorific value of the fuel, which for the gasoline was 19,100 British thermal units per pound and for the denatured alcohol was 10,500 British thermal units per pound.

As has been previously published, alcohol can be used with more or less satisfaction in stationary and marine gasoline engines, and these gasoline engines will use from one and one-half to twice as much alcohol as gasoline when operating under the same conditions. The possibilities, however, of altering the ordinary gasoline engine as required to obtain the best economies with alcohol are very limited; for the amount that the compression can be raised without entirely redesigning the cylinder head and valve arrangement is ordinarily not sufficient, nor are the gasoline engines usually built heavy enough to stand the maximum explosive pressures, which often reach 600 and 700 pounds per square inch. With the increase in weight for the same sized engine, designed to use alcohol instead of gasoline, comes an increase in maximum horsepower a little over 35 percent, so that its weight per horsepower need not be greater than that of the gasoline engine, and probably will be less.

THE INFLUENCE OF MIDSHIP-SECTION SHAPE UPON THE RESISTANCE OF SHIPS.*

BY D. W. TAYLOR, NAVAL CONSTRUCTOR, U. S. N.

The question of the influence of the shape of the midship section of a vessel upon its resistance is one concerning which the opinions of naval architects differ a good deal. The object of this paper is to lay before the society information throwing some light upon the question, obtained from experiments at the United States Model Basin during the past year. It should be pointed out in advance and carefully borne in mind that, though the actual area of the midship section in a given case may have large influence upon resistance, this is a subject not taken up in the present paper, which deals only with the effect of the shape of the area, not the area itself.

The question of shape of midship section was investigated by means of five types of lines, all the product of Draftsman-in-Charge W. T. Powell. Forty models were tried in all, their data being given in Tables I and II.

Table I refers to the twenty models which had a cylindrical or prismatic or longitudinal coefficient (*l*) of .56, being thus rather fine-ended models. Table II refers to the twenty

* Read before the Society of Naval Architects and Marine Engineers, New York, November 19, 1908.

TABLE I.

Data of models of .56 longitudinal coefficient used for midship section coefficient experiments. Mean immersed length of all models, 20.00 feet. Water-line length of all models, 20.512 feet.

Model No.	Displacement of Model in Fresh Water, Pounds	Midship-section Coefficient	Model Dimensions. Beam, Feet.	Model Dimensions. Draft, Feet.*	Displacement length Coefficient, Salt Water.
826	....	.70	4.187	1.432	
830	....	.80	3.916	1.340	
834	3,000	.90	3.692	1.263	159.6
838	....	1.00	3.503	1.198	
842	....	1.10	3.339	1.142	
827	....	.70	3.627	1.241	
831	....	.80	3.393	1.161	
835	2,250	.90	3.199	1.094	119.7
839	....	1.00	3.035	1.038	
843	....	1.10	2.893	.990	
828	....	.70	2.961	1.013	
832	....	.80	2.769	.948	
836	1,500	.90	2.611	.893	79.8
840	....	1.00	2.477	.847	
844	....	1.10	2.361	.808	
829	....	.70	2.417	.827	
833	....	.80	2.261	.774	
837	1,000	.90	2.132	.729	53.2
841	....	1.00	2.022	.692	
845	....	1.10	1.928	.660	

*All models tested on even keel.

TABLE II.

Data of models of .68 longitudinal coefficient used for midship-section coefficient experiments. Mean immersed length of all models, 20.00 feet. Water-line length of all models, 20.512 feet.

Model No.	Displacement of Model in Fresh Water, Pounds.	Midship-section Coefficient.	Model Dimensions. Beam, Feet.	Model Dimensions. Draft, Feet.*	Displacement length Coefficient, Salt Water.
889	....	.70	3.283	1.123	
893	....	.80	3.071	1.051	
897	2,250	.90	2.895	.991	119.7
901	....	1.00	2.747	.940	
905	....	1.10	2.618	.896	
890	....	.70	2.681	.917	
894	....	.80	2.508	.858	
898	1,500	.90	2.364	.809	79.8
902	....	1.00	2.243	.767	
906	....	1.10	2.138	.732	
891	....	.70	2.188	.749	
895	....	.80	2.047	.701	53.2
899	1,000	.90	1.930	.660	
903	....	1.00	1.831	.626	
907	....	1.10	1.743	.597	
892	....	.70	1.548	.530	
896	....	.80	1.448	.495	
900	500	.90	1.365	.467	26.6
904	....	1.00	1.295	.443	
908	....	1.10	1.234	.423	

*All models tested on even keel.

models which had a longitudinal coefficient of .68, being thus full-ended models. The ratio of beam to draft for all models was 2.923.

It will be observed that the slenderness of these models, if I may apply this expression, is characterized by what I call "Displacement Length Coefficient," or $\dfrac{D}{\left(\dfrac{L}{100}\right)^3}$, where D is displacement in salt water in tons and L is length on water line in feet. This coefficient is also the displacement in tons of a vessel upon the lines of the model and 100 feet long. It is a convenient coefficient to use when dealing with questions of speed.

There were five separate midship-section coefficients (m) used; namely, .7, .8, .9, 1.0 and 1.1. Each coefficient was used with the two longitudinal coefficients and with four displacements or four displacement length coefficients. Fig. 1 shows the five types of lines for five vessels 400 feet long and of 7,662 tons displacement, the longitudinal coefficient of each being .56. Change of displacement for fixed longitudinal and midship-section coefficients was obtained by changing both beam and draft the same percentage. The same parent lines were used for each longitudinal coefficient.

The variations in fullness were obtained by shifting the sections fore-and-aft. Fig. 2 shows the two curves of sectional area used for the longitudinal coefficients (l) .56 and .68. They both, in this case, refer to a 400-foot vessel of 7,662 tons displacement. For identical displacements as in Fig. 2, the actual midship-section area for the .68 coefficient is less than that for the .56 coefficient, but the midship sections themselves are similar. The similar area corresponding to the .68 coefficient was obtained by reduction of dimensions from the larger area required by the .56 coefficient. The method of passing from one form to another is indicated in the figure. Thus at station 33 the area required for the .68 coefficient vessel is 582 square feet. This area is 582 ÷ 987 or .590 of the midship area of the .68 coefficient vessel, which is 987 square feet. The midship area of the .56 coefficient vessel is 1,198 square feet; .590 of this 707 square feet, which is found at station 30, hence the section at 33 on the .68 ship is the section at 30 on the .56 ship reduced in size from 707 square feet to 582 square feet, both beam and draft being reduced in the same proportion.

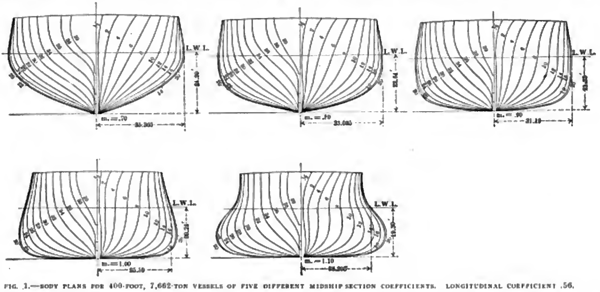


FIG. 1.—BODY PLANS FOR 400-FOOT, 7,662-TON VESSELS OF FIVE DIFFERENT MIDSHIP SECTION COEFFICIENTS. LONGITUDINAL COEFFICIENT .56.

Taking up now the relative resistances, these may be considered under two heads; namely, frictional resistance and residuary resistance, the latter being mostly wave making. The frictional resistance is assumed to depend only upon the wetted surface. The wetted surface is very conveniently expressed by a formula in a paper by me to be found in Volume I (1903) of the transactions of the society; namely, $S = C\sqrt{DL}$ where S is the wetted surface in square feet, C is the coefficient, D is the displacement in tons in salt water, and L is the mean immersed length in feet.

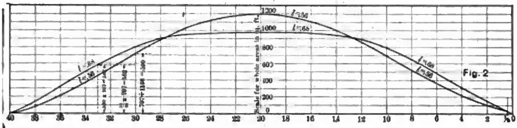


FIG. 2.—CURVES OF SECTIONAL AREAS OF 400-FOOT, 7,602-TON VESSEL FOR LONGITUDINAL COEFFICIENTS .56 AND .68.

Figures 3 and 4 give curves of wetted surface coefficient deduced from calculations for the forty models and plotted upon midship-section coefficient in each case. Fig. 3 refers to the longitudinal coefficient of .56 and Fig. 4 to the longitudinal coefficient of .68. The four curves of each figure refer to separate values of displacement length coefficient as indicated.

It is seen that, broadly speaking, there is in each case a minimum wetted surface which occurs for midship-section coefficient a little above .90 in the case of the fine-ended models, and a little below .90 in the case of the full-ended models. Very fine midship section and very full midship section both involve an increase of wetted surface, but since, in practice, midship-section coefficients greater than unity are not used, the practical conclusion to be drawn from Figs. 3 and 4 is that for midship-section coefficients between .85 and 1.00 there is little variation of wetted surface due to the midship-section coefficient alone. For very fine midship sections, as .7 for example, there is an appreciable increase in wetted surface and a corresponding increase in frictional resistance, although this increase is not serious. In passing, it may be remarked that a comparison of Figs. 3 and 4 will show that for midship-section coefficient about .84 the absolute wetted surfaces are almost identical both for the fine-ended ships and the full-ended ships. Above this coefficient the wetted surfaces are slightly less for the fine-ended ships, and below this coefficient they are slightly less for the full-ended ships.

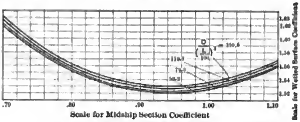


FIG. 3.—CURVES OF WETTED-SURFACE COEFFICENTS. LONGITUDINAL COEFFICENT .56.

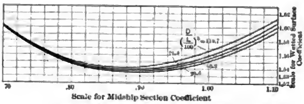


FIG. 4.—CURVES OF WETTED-SURFACE COEFFICIENTS. LONGITUDINAL COEFFICIENT .68.

Coming now to the question of residuary resistance, Figs. 5 and 6 give forty curves of residuary resistance obtained from the forty models tried. These curves are plotted not on actual speed or in terms of actual resistance, but upon the speed-length ratio $\frac{V}{\sqrt{L}}$ and with resistance expressed in pounds per ton. This means that they are applicable, regardless of size. It will be seen that, broadly speaking, within the limits of practicable speed, the residuary resistance is less the greater the midship-section coefficient.

For Fig. 6 (longitudinal coefficient .68) the residuary resistance is less at all speeds, with almost no exception. For the curves of Fig. 5 (longitudinal coefficient .56), at speeds below the speed-length ratio of from 1.1 to 1.2 the large midship-section coefficients have the advantage. Above this point in Fig. 5 the results are somewhat confused, but, as a general thing, the finer the midship-section coefficient the less the resistance. It should be borne in mind, however, that these

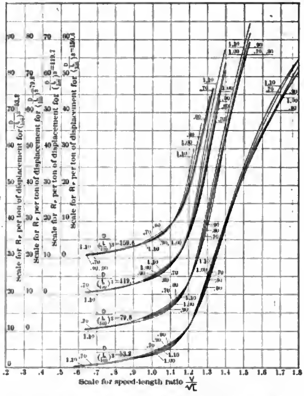


FIG. 5.—CURVES OF RESIDUARY RESISTANCE PER TON OF DISPLACEMENT. LONGITUDINAL COEFFICIENT .56.

higher speeds are beyond the speeds obtained in practice by vessels of this type. For such high speeds the longitudinal coefficient of .56 is too small and, while .68 is rather high, it is closer to the best coefficient than .56. It will be found, for instance, that at the highest speeds the resistances for the same values of displacement length coefficient are less in Fig. 6 than in Fig. 5.

Figs. 3, 4, 5 and 6 deal with separate elements of resistance. As expressing more definitely concrete results, curves of total effective horse-power as estimated from the experiments, for a large vessel of .56 longitudinal coefficient and for a small vessel of .68 longitudinal coefficient were plotted. Five curves corresponding to the five midship-section coefficients were made in each case, and it is seen that here, too, the large coefficients have a little the best of it.

A natural tendency is to associate fineness with speed and to suppose that a fine midship section is favorable to speed.

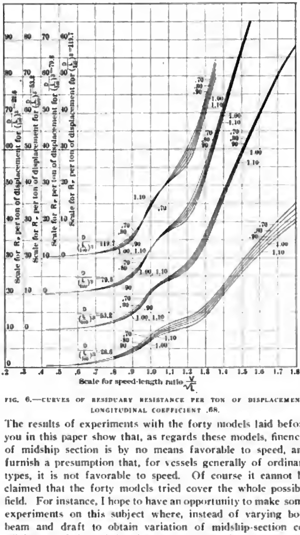


FIG. 6.—CURVES OF RESIDUARY RESISTANCE PER TON OF DISPLACEMENT. LONGITUDINAL COEFFICIENT .68.

The results of experiments with the forty models laid before you in this paper show that, as regards these models, fineness of midship section is by no means favorable to speed, and furnish a presumption that, for vessels generally of ordinary types, it is not favorable to speed. Of course it cannot be claimed that the forty models tried cover the whole possible field. For instance, I hope to have an opportunity to make some experiments on this subject where, instead of varying both beam and draft to obtain variation of midship-section coefficient, draft is varied and beam not changed. It seems reasonable to conclude, however, that the shape of the midship section has a comparatively minor influence upon the speed, and that the midship-section coefficient may range from .85 to 1, with very little effect upon speed, and may be made as low as .70 without a material increase in resistance.

A reasonable explanation of the results I have laid before you may, I think, be deduced from an inspection of Fig. 1. It is seen that the fine midship sections are associated with the large dimensions. This is necessarily the case when we separate the question of midship-section coefficient from the question of midship-section area. If area is constant, smaller coefficients must mean larger dimensions. For instance, keeping the area of midship section constant for the vessels of Fig. 1 and passing from the extreme midship-section coefficient of 1.1 to .7, we increase the draft from 19.3 to 24.2 feet and the beam from 56.41 feet to 70.73 feet. Increased beam and draft mean increased disturbance of at least a portion of the water through which a ship passes.

The results of the special series of experiments on this subject are in full accord with our general experience at the Model Basin. Among the very large number of model experiments we have made, we have had no results indicating any material influence of shape of midship section upon resistance. For vessels of extreme types and extraordinary speeds there may be great virtue in some special form of midship section—yet to be discovered—but our general model-basin experience and the special experiments described above appear to warrant the conclusion that for vessels of usual types and of speeds in knots no greater than twice the square root of the length in feet, the naval architect may vary widely midship-section fullness without material beneficial or prejudicial effect upon speed.

STEAMSHIP ENGINEERING ECONOMIES.

BY A MARINE ENGINEER.

In these days of fierce and, in many cases, foolish competition, no occupation feels the effect of this stress more than the shipping industry, especially as it applies to our seaborne freight-carrying trade. It therefore behooves all those interested in the country's welfare, and particularly those concerned in the shipping trade, to put forward every effort to keep working costs down to a minimum.

Taking, for example, the case of a steamer after it has left the home port, the shipowner or his representatives practically lose all control over the vessel, and must of necessity leave it entirely in the hands of the ship's crew, from the captain downwards. While admitting that the captain of a ship can save a good deal of money to his owners by taking the shortest and safest course between two ports, and also by seeing to it that he gets as quick a discharge for his cargo as possible when in port, it must also be allowed that a good deal of the economical running of a ship depends upon the care and efficiency with which the engineering staff of the boat carry out their duties. It may, therefore, be worth while going over a few of the points in which engineering economics may be made in marine practice.

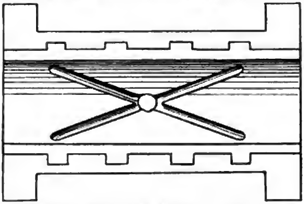
Economies in the steamship, as in other branches of engineering operations, begin with the boiler plant, and unless this part of the ship has the utmost care of the staff a great deal of expensive steaming will be the result. In the first place, the boilers ought to be kept as free from scale and dirt as possible. This can be done effectually and well by periodically cleaning them externally and internally, and by the use of an evaporator for treating the make-up water required for the boilers. The use of a feed-water heater would also be of great advantage in tending to cause the water to deposit any foreign matter in the heater where it can be easily blown off instead of letting it get into the boiler, where a complicated cleaning process is necessary. A certain kind of efficient boiler compound is also very useful in removing scale from boiler surfaces and in the prevention of corrosion. As, however, the writer holds no brief from the makers of this compound its name need not be stated, although he has used it with advantage in a number of boilers where scale and corrosion were very troublesome. Another simple and effective method of preventing corrosion is to apply a wash of Portland cement to the boiler plates. This prevents any acid compound in the feed water from attacking the iron of the plates.

A saving in coal consumption can be made by the use of a superheater. It is well known that a saving up to 10 percent can be effected by this means, and in the writer's opinion nothing much can be gained by using steam in a reciprocating engine at a higher temperature than 450 degrees. By placing the superheater at the root of the funnel and allowing the escaping gases from the boiler to pass round it, a sufficiently large saving is the result to warrant the capital expenditure on the superheater to be made. It should hardly be worth mentioning, except for the lamentable failures sometimes found on board ship, that all boiler connections should be kept in as good condition as possible, especially the blow-down and scum cocks.

The fire should be very carefully attended to. One of the chief points of supervision should be to make sure that the fireman takes as short a time as possible in cleaning fires. He should also be instructed to keep as even and moderately thick a fire as possible. In a natural draft stokehold, for example, fires from 4 inches to 4½ inches are usually the best practice. It is a common occurrence for firemen to fill up their fires as much as they will hold, in order to enable them to get a longer idle spell, and it is extremely difficult to get this class of man to desist from this bad habit. Probably, however, a little encouragement in the form of a bonus given to the men who keep the best fires will go a long way towards leading to more economical coal consumption. The firemen should also be very carefully taught the use of the dampers, to allow the proper amount of air to pass into the furnaces, increasing the percentage of carbon dioxide in the furnace gases. Assuming that the boilers were in the first place well designed, the efficiency maintained in the stokehold of a ship would be very high if the foregoing points were carefully attended to.

We now come to the consideration of the engine room, the first point of interest being the main engines. The piston, packing rings and valves of these engines ought to be maintained in as good a condition as possible. A very fruitful source of trouble and expense is found in the heating of the bearings on the crank pins and also in the main bearings, thus causing a stoppage or slowing down of the engines. This trouble could be almost entirely obviated, assuming that the bearings had been designed with liberal bearing surface, either by a more careful regulation of the oil supply or by the provision in the bearings of properly constructed oil channels. In the writer's experience with two sets of quadruple expansion engines of very large horsepower, a great deal of trouble and stoppage was caused on the first voyage by the heating of the crank pin bearings, notwithstanding the fact that the engines were built by a firm of high-class engine builders. On arrival at the home port all of the bearings were taken apart and thoroughly examined. The white metal was found to be of good quality, and oil channels were provided in the bearing metal. It was, however, considered that these oil channels were not all that could be desired, and they were further altered by being cut, as shown in the sketch, the channels being made ⅛ inch deep by ¼ inch broad, and well rounded at the edges. This was done to both the crown and bottom brasses, and, apparently, this cured the trouble, because the bearings worked perfectly cool on the next trip.

In marine work the oiling system as arranged for the usual reciprocating engine is far from being perfect. In most cases it consists simply of a box filled with oil fitted to each bearing, the lubricating action being dependent on the capilliary effect provided by the siphons. A much better arrangement would be to have the oil tank placed above the top grating in the engine room, and fastened to the bulkhead; the bearings would then be fed with oil at a pressure corresponding to the height between the tank and the engine bearings. The crank pits of the different engines could be semi-enclosed, which would prevent loss of oil, and made watertight in order to prevent the bilge water from mixing with the oil; such oil and water as collected in the crank pits could be led by pipes into a tank made in the form of a combined cooling tank and filter, placed in the same position as the engine room ballast tank. This tank could be fitted with two fine gauze screens, of different mesh, to catch any impurities in the oil, and the lubricant could then be pumped through two or three coils of tubes on its way back to the storage tank at the top of the engine room. A portion of the circulating water for the condenser could be used for the purpose of cooling the oil, and the cost would not be much greater than that of the systems in vogue at the present time. In any case, it would more than repay itself for any extra outlay in the smoother running of the engine and decreased number of hot bearings. One greaser would be able to look after a larger amount of the plant, as he would have little or nothing to do with the ex-



SKETCH SHOWING ALTERATION OF OIL CHANNELS IN CRANK-PIN BEARINGS.

ception of swabbing the rods. In large ships carrying more than one greaser per watch a saving of a greaser's wages would be found possible.

Another source of economy would be found in the use of metallic packing on the piston rods of all the engines, as this class of packing requires very little lubrication and adjusts itself very readily to the working position of the piston rod. In the writer's experience the rod has been out of line to the extent of 3/16 inch, and yet the packing has worked perfectly satisfactorily. Moreover, the up-keep of this type of packing is very small. The writer has known it to run for four years without being looked at, and at the end of that time the only refitting necessary was that one of the rings had to be refilled with white metal. After an experience of ten years with this packing the writer may say that he has not once had to stop an engine owing to trouble with the packing after it had been properly fitted and adjusted. It may possibly leak a little for a day or two after being fitted to the gland until it becomes bedded on the rod, but after this it will remain perfectly dry.

In large vessels the auxiliary plant forms a very considerable part of the total horsepower of the ship and requires a considerable amount of attention in up-keep. In the case of reciprocating engines, where the air and circulating pumps are driven from the intermediate pressure engines, this is found to be a most economical arrangement, but in the case of large ships the circulating pump is usually driven by an independent engine. A much better method of driving this would be by means of an electric motor, and where the bilge pumps are driven by a separate engine a motor would also be an advantage in place of the steam engine. Deck pumps and smaller auxiliary apparatus should also be run electrically, and this could be easily and cheaply arranged, as most of the modern ships have an electric plant on board for lighting. This plant could be increased in size for comparatively small capital cost to enable it to take the load of these extra motors. In most ships the electrical generating plant has to run for 24

hours per day, with often an output of not more than 10 percent of the full load of the machine. By having the pump load in addition to the small day lighting load, the output of the machine could be increased to something like its full load, which would increase the efficiency of the machine and reduce the running costs very considerably. Moreover, as a stand-by set is usually provided this could be run for peak loads in the evening, and this would not only increase the economy of the engine room in steam consumption, oil, repairs and attendance, but space and weight would also be reduced, giving a greater margin for the carrying capacity of the ship.

It will now be interesting to consider the deck plant, such as the capstan, steering engine and engines in the case of winches driven by steam. There is, first of all, the long length of steam pipes which have to be carried from one end of the ship to the other, with valves scattered here and there, and the consequent loss due to condensation and radiation of heat. In addition to this there is the leaky joint, which is almost inseparable from this class of work and which deteriorates the wood planks composing the decks very rapidly. Again, the uneconomic winch engine itself very frequently has its cylinder quite uncovered with the exception of a coat of paint. It usually boasts of a leaky stop valve and slide valves; there is general heavy wear and tear on the brasses of this very useful but uneconomical machine, and lastly, but by no means least, there is the hideous noise made by its gearing. By having these machines driven by electric motors, no unsightly and leaky steampipes would be seen, wear and tear would be materially reduced, and noise, with its consequent misunderstandings between the men in the hold and those on deck, would be abolished; and also the saving in steam would be very large. Supposing, however, that a motor drive cannot be applied to a ship which has a steam winch, it should at least be arranged so that the exhaust steam of the winch engine would be utilized to heat the feed water of the main boilers by means of an exhaust feed heater. The steering engine would be replaced by a motor working with a reduction gear, and the capstan could be dealt with in precisely the same way. When ash expellers are not installed a motor could be installed for hoisting up the ash from the stokeholds.

In a number of the modern liners some of the improvements suggested above have, of course, been adopted, but the majority of ships still have a long way to go in adopting more economical methods of driving their auxiliary plants. Probably this conservatism is largely due to the fact that the consulting engineers of these ships have had little or no experience with electrical machinery and are afraid to recommend its use in vessels under their supervision. The idea seems to have become fixed in their minds that electric motors are not so reliable as a steam plant, but this feeling ought to be driven from their minds by inviting them to investigate for themselves the amount of electrically-driven auxiliary apparatus which is used in all our large electric generating stations throughout the country. Moreover, it should be remembered that there are numberless large manufacturing industries which have taken up the electrical system of driving, and which run continuously day and night without any trouble. One has only to look at the progress which is being made every day in the electric driving of fans and pumps in large collieries throughout the country to understand how reliable the electric plant has become, inasmuch as many hundreds of men are dependent upon the uninterrupted operation of these essential parts of a mine equipment. Manufacturers' representatives do not push this part of the field for electric plant as keenly as they might do, and a good deal of work is waiting for the firms who can successfully take up the work of equipping our mercantile marine.

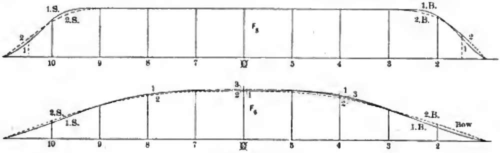


FIG. 1.—CURVES OF SECTIONAL AREAS.

FURTHER EXPERIMENTS UPON LONGITUDINAL DISTRIBUTION OF DISPLACEMENT AND ITS EFFECT UPON RESISTANCE.*

BY PROFESSOR HERBERT C. SADLER.

In a paper read before the society last year the results of some experiments upon resistance as affected by distribution of displacement were given for one form of .73 block coefficient. Since that time similar experiments have been carried out upon the same general lines, for finer and fuller forms, the particulars of which, including those of last year (F7), are given below.

PARTICULARS OF MODELS.

Series No.	$\frac{L}{B}$	$\frac{B}{d}$	$\frac{L}{d}$	Coefficients.		
				Block.	Prism.	Midship.
F6 (1)	8	2.142	17.142	.6533	.6778	.9638
F7	8	2.142	17.142	.733	.760	.964
F8	8	2.142	17.142	.855	.869	.984

The curves of sectional areas are shown in Fig. 1. In each case the same general idea has been followed, viz., the dimensions, displacement and coefficients have been kept constant for each series and the distribution of displacement modified by altering the curve of sectional areas. In the models where a parallel middle body was used, this was held rigidly for the distance shown on the curve of sectional areas, and was therefore "actual parallel middle body" and not "virtual middle body." The general shape of the sections was also kept constant. The various models were tried at three different drafts and some at different trims, but those for the maximum draft only are given, as the resistance curves for the other drafts follow the same general form.

The fine bow and stern accompanied by parallel middle body are marked 1B and 1S, and the fuller bow and stern with no middle body, or, in the case of the fullest type, a reduced middle body 2B 2S. Combinations of the two, such as the fine bow with the full stern, are distinguished by the letters 1B 2S. In each case four models were made representing all the combinations possible with the given curves of sectional areas.

* Read before the Society of Naval Architects and Marine Engineers, New York, November 19, 1908.

Dealing in the first place with the fullest form F8, it will be noticed that there is not much scope for very great variation in form owing to the shortness of the ends. In the models tried, the difference between the two extreme forms is represented by an increase of 10 percent in length of middle body. The curves of residuary resistance per ton of displacement are shown in Fig. 3 for the various combinations of bows and sterns, and the comparative results in the following table:

COMPARATIVE RESIDUARY RESISTANCE.

$\frac{V}{\sqrt{L}}$	1B.1S.	1B.2S.	2B.1S.	2B.2S.
.5	100	80	84.5	56
.55	100	77.7	79.0	50.6
.6	100	74	72	53.0

The form with the fine ends and longer middle body is decidedly the worst, while that with the shorter middle body and fuller ends is the best. Between the combinations of ends there is little to choose. The results for this form are therefore the opposite to those obtained for the finer forms, but the explanation of this is probably as follows. Owing to the shortness of the ends it is possible to obtain only a very short length of line at the extreme end, which can be reduced in fullness. This reduction must be immediately followed by an increase and, consequently, a rather abrupt shoulder where the lines run into the middle body. In fact, in the form with the finer ends, the length could be reduced about 2 percent at each end by "snubbing," with little or no effect upon the resistance. It will also be noticed that although the angle of entrance at the extreme end is much less in the form with the fine ends, the real mean angle of entrance over, say, one-half of the fore or after body, is actually less in the form with the fuller ends.

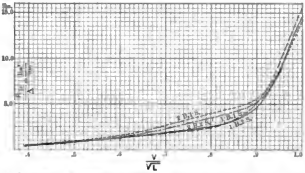


FIG. 2.—CURVES OF RESIDUARY RESISTANCE PER TON OF DISPLACEMENT FOR MODEL F6.

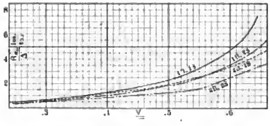


FIG. 3.—CURVES OF RESIDUARY RESISTANCE PER TON OF DISPLACEMENT FOR MODEL F8.

Reference to the wave profiles for the different forms shows what happens at the ends, and explains some of the difference between the resistance curves for 1B.1S and 2B.2S. At almost any speed there is a marked secondary bow wave in the forms with the fine ends, at the point where the fore body begins to run into the middle body. The two forms of stern show somewhat the same effect, a marked hollow occurring in the fine stern type, in about the same relative position from the stern.

Referring now to the finer form F6, the curves of sectional areas marked 1B.1S and 2B.2S represent the various modifications in the different models; the form with the fine end having 20 percent, and that with the full ends no middle body. The curves of residuary resistance are shown in Fig. 2, and the comparative results in the following table:

COMPARATIVE RESIDUARY RESISTANCES.

$\frac{V}{\sqrt{L}}$	2B.1S.	2B.2S.	1B.1S.	1B.2S.
.75	100	86.5	62.6	64.5
.8	100	87.6	61.7	63.5
.85	100	91.2	71.7	69.5

In this case the form with the full bow shows a marked inferiority to that with the fine bow, within the range of speed suitable for this form. At higher speed-length ratios the somewhat easier form represented by 2B.2S seems to show up a little better than the one with the finer bow. The fuller and easier after-body also seems better than the finer form. On the same basis of curve of sectional areas in the above series, two more models were made, but of greater beam. No. 2 had exactly the same curve of sectional areas as No. 1, the beam only changed. In No. 3 the same beam was taken as No. 2, but the area of the midship section was increased to compensate for the reduction of displacement, due to cutting away the form between sections 3 and 5 (Fig. 1). Nos. 1 and 2 have therefore the same prismatic, but different block coefficients, while Nos. 2 and 3 have the same block but different prismatic coefficients. The lines at the extreme ends in all cases are the same.

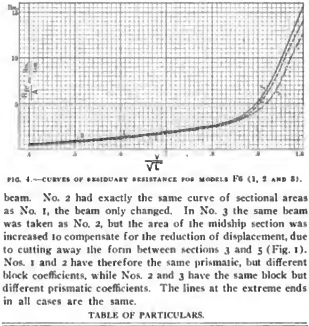


FIG. 4.—CURVES OF RESIDUARY RESISTANCE FOR MODELS F6 (1, 2 AND 3).

TABLE OF PARTICULARS.

No.	$\frac{L}{B}$	$\frac{B}{d}$	$\frac{L}{d}$	Block.	Prism.	Midship.
F6.1	8	2.142	17.142	.6533	.6778	.9638
F6.2	7.272	2.142	17.142	.594	.6778	.874
F6.3	7.272	2.142	17.142	.594	.664	.895

The curves of residuary resistance are shown in Fig. 4, and the comparative results in the following table:

COMPARATIVE RESIDUARY RESISTANCES.

$\frac{V}{\sqrt{L}}$	F6.1	F6.2	F6.3
.8	100	96	96
.85	100	95.4	92.3
.9	100	92.3	81.2

Up to a speed-length ratio of .8 there is very little to choose between the three forms, but above that speed the effect of widening and fining the midship section is apparent by comparing curves 1 and 2. By reducing the prismatic coefficient

still further, as in No. 3, there is a further reduction in residuary resistance. In fact the curve of sectional areas of No. 3 has all the good and none of the bad points of Nos. 1 and 2, the ends being fine and the lines towards the middle of a gradual character with no sudden change.

In practice, especially where the mold system is used, it is of advantage from a builder's point of view to have as much parallel middle body as possible. In the above series and in those given last year, this point has been kept in view. The three series, F6, F7, and F8, represent a range of models of .6 to .85 block coefficients.

An investigation of the curves of residuary resistance shows that in the first place it is of decided advantage to use a parallel middle body and a fine bow up to forms with about .8 block coefficient. Beyond that degree of fullness, the reverse is true, owing to the reasons discussed above.

There is no doubt that further improvements in performance may be obtained by fining the bilge diagonal, especially in the neighborhood where the parallel middle body joins the ends. In such cases, however, although there would be a virtual middle body, the actual middle body would more or less disappear. Further experiments upon this point are now under investigation. It may be of interest to note that in all the forms tested, where the ends were fine and accompanied by a somewhat abrupt change to the parallel middle body, the resistance at very low speeds always appeared to be higher than in those where the ends were fuller and the forms more gradual.

In any form there seems to be a certain combination of fineness of waterline forward and curve of sectional areas which will give the best result. In other words, in the neighborhood of the waterline it is of advantage to keep the form fine, but at some distance from the bow, there is what might be called a "governing section" to the form, which section should not be too full on the diagonal. Reference to the stream lines around models which were shown by Mr. Taylor last year, seems also to bear out the foregoing.

As a further illustration of this point, in the model of the F6 series with the full ends and no middle body (2B.2S), the same curve of sectional areas was held, but the fore body changed by fining the waterline and club footing the sections forward. The result at speed-length ratios of .75 to .85 was a diminution of the residuary resistance of about 9 percent; while in the form with the still finer waterline forward (1B.2S) the average over the same speeds was about 25 percent.

So far as the after-body is concerned, the most advantageous form appears to be one where the curve of sectional areas is of an easy character somewhat full on the waterline, and with an easy bilge diagonal.

The influence of shape of section upon the resistance when the curve of sectional areas remains the same, has not, however, been investigated, but some experiments are being made upon this point and will be submitted at a later date.

Speed in Warship Construction.

Few people realize when considering the noteworthy record which has just been made in launching the battleship *North Dakota*, 60 percent complete, in a period of ten and three-quarter months, that one of the oldest vessels in the United States navy was on the stocks nearl fifty years from the time of laying the keel to the time of launching. In 1817 the keel was laid at the Portsmouth (N. H.) navy yard for an 84-gun ship of the line, named the *Alabama*. This ship was not launched until 1864, when she was hurriedly completed for service in the Civil War. Also of six double-turreted monitors authorized in 1886-1887, with one exception, from seven to twelve years elapsed between the laying of the keel and the launching of the vessel.

A NEW GAS-ENGINE CYCLE.

BY ROBERT MILLER.

While investigating the subject of internal-combustion engines, the writer was impressed by the lack of agreement between the axioms laid down by Beau de Rochas in 1862 and his cycle brought to a working basis by Dr. Otto. Briefly, these axioms are:

1. Highest possible pressure at beginning of stroke.
2. The maximum speed of expansion.
3. Expansion to the lowest possible pressure.
4. The maximum cylinder volume with minimum wall space.

The present two and four-cycle engines fall short of these ideals for the following reasons:

1. The highest possible pressure for a given compression is not reached, because of imperfect scavenging.

2. The speed of expansion is limited to the piston speed, which must be kept down for mechanical reasons. In this respect the "free-flying piston" engine is ideal, but out of the question for modern service.

3. Expansion is not carried very far; pressures as high as 60 pounds per square inch are often rejected to the exhaust.

4. Maximum volume with minimum surface is counteracted by excessive wall cooling, made necessary by pre-ignition conditions and charge reduction.

To approach nearer the ideal, the writer devised the following cycle:

1. The entire cylinder, with clearance, is scavenged by an excess of pure, cold air, which therefore gives a higher initial pressure.

2. During the expansion stroke the combustion cylinder is connected to a larger supplemental cylinder with piston, so that the speed of expansion shall be faster than that with the smaller cylinder alone.

3. The supplemental cylinder brings the expansion to a low terminal pressure.

4. Cooling is required only for the purpose of lubrication, the fuel component being added during the compression stroke

The design of an engine embodying these features allows also some other very desirable ones: self-starting, reversing, double acting, etc., as treated more fully below.

DESCRIPTION OF THE CYCLE.

Referring to the drawings, we shall go through a complete cycle in one cylinder, the drawing showing a single-crank double-acting engine. Assume that in the clearance space *a* (upper cylinder) an explosion is about to occur. At that momen the valve *b*, being open, establishes communication between the combustion chamber *a* and the supplemental expansion chamber *c* (whose area is twice that of *a*), the valve *d* being closed. The result is that the force of this explosion is expended in the cylinders *a* and *c*, so that the expansion will be very rapid, and as the piston reaches the end of its stroke the volume of the combined cylinders *a* and *c* will be three times greater than that of *a* alone. The expansion must then have been carried down to about 5 pounds to the square inch pressure, with the result that, due to the rapidity of the expansion, little heat has passed through the cylinder wall.

While the differential piston was moving in this direction, having on one side the explosive impulse, on the other side it was compressing (to a slight degree) the pure air contained between it and the head; in the lower cylinder, of course, the crank case is used for this preliminary compression. As the differential piston nears the end of its stroke the valve *d* will open so that the remaining pressure in the cylinders *a* and *c* will escape through the exhaust port in this valve. As this pressure dies away, the slightly compressed air on the other side of the piston comes up through the connecting pipe, through the body of the valve *d*, and out through the ports *g*. As the pure air emerges from ports *g* it traverses the body of the cylinder and clearance *a*, goes through the valve *b*, the

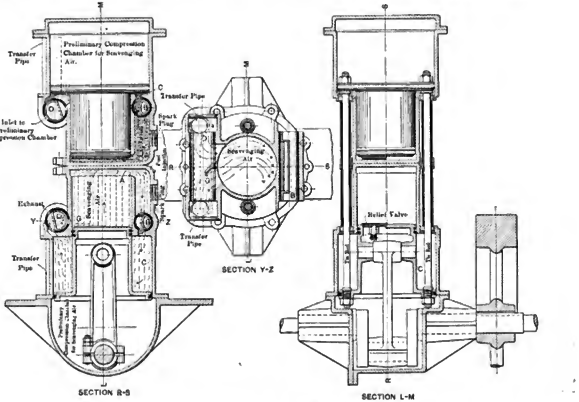
chamber c, and discharges through the exhaust port of valve d.

The piston now starts on its return stroke. Valve b closes and the pure cold air in a will be compressed for the next impulse, the fuel being added during this stroke. While this new charge is being compressed, the supplemental chamber c is expelling its contents through the exhaust port in valve d, and the other side of the piston is drawing in a new charge of air, as in the ordinary two-cycle engines.

Just before ignition occurs valve d is closed and valve b gradually opened. As ignition occurs the cycle repeats.

To illustrate the increase in expansion speed, assume a piston speed of 900 feet per minute and a stroke of 12 inches. The ordinary cylinder will expand its charge from, say, 300 pounds to 45 pounds per square inch in one stroke, or in 1/900 minute. The Miller cycle expands the same charge, between the same limits, in one-third of 1/900, or 1/2700

The chief difficulty with the two-cycle engine is the time element, giving imperfect scavenging. In the large 1,000-horsepower European engines of this type it is usual to consider that scavenging commences at the outer dead center, because as the exhaust ports open the gases do not drop to atmospheric pressure instantly. The scavenging commencing at dead center, much valuable time has been lost, as this is the slow period of the stroke. With the Miller cycle, however, the results are vastly different. The pressure of the gases being brought down to a low point by the expansion cylinder, as the exhaust port opens, very little pressure drop is necessary before the scavenging charge enters. The result is that while the piston is approaching dead center, turning dead center, and returning to close the air port scavenging is going on. This large increase in the available time, so important with two-cycle engines, is of the greatest advantage.



SECTIONAL VIEWS OF THE MILLER SINGLE CRANK, DOUBLE ACTING GAS ENGINE.

minute. This method of increased expansion differs widely from the two commonly attempted. The true compound gas engine (two-stage expansion) fails because of the low specific heat of the working fluid, the transference of highly-heated gases through small ports and valves, which must be kept cool to insure durability, and the enormous amount of cooling surface in the high and low-pressure cylinders.

The other method of using a small charge (cut short on the suction stroke or expelling some on the compression stroke) involves a long stroke, and what is gained by increased expansion is lost by increased time of contact with water-cooled cylinder walls.

The gain with the Miller cycle in fuel economy and in lightness will be due to the conversion of more heat into work during the expansion stroke, instead of being wasted through the cylinder wall and the exhaust, the increased charge weight and mean effective pressure, because the new charge is pure, cold air at atmospheric pressure, and the addition of the fuel during the compression stroke.

Air cooling for marine service appears quite radical. But it can be shown that for medium-sized engines the internal cooling, as used here, is sufficient; whereas, for larger sizes the exterior portions could be cooled by the use of air jackets, through which a large volume of cold air could be drawn by an ejector operated by the large volume of the exhaust.

The internal cooling is, of course, due to the combined action of the method of scavenging and the lower wall temperature resulting from the mode of expansion. Other cycles hold the high temperatures so much longer that the heat flow into the walls must be much greater than with this cycle. Dugald Clerk has shown, experimentally, with a four-cycle engine that during the exhaust as well as during the compression stroke heat flows to the jackets. With the Miller cycle it is safe to assume that with the lower wall temperaures, resulting from the simultaneous expansion feature, the cold scavenging charge will prevent the head of the piston from accumulating too much heat, will chill the interior surface of the cylinder bore, where the oil is, cool the valves, and keep

within limits the temperature of the surface of the expansion cylinder. Cooling is really required in this engine only for the purpose of lubrication.

It must not be forgotten that the injection of the fuel in the liquid form also has its effect in lowering the temperature of the compressed air. Being a liquid it must, to assume the gaseous state, abstract heat from its surrounding medium.

Not the least of the advantages with this method of cooling is the elimination of much pattern and foundry labor, the freedom from danger of cracked cylinders in cold weather, and the doing away with troubles due to the deposits of saline matter in the jackets, with consequent overheating.

While the method of adding the fuel component to the charge by injecting it during the compressing stroke is not new, yet as applied to this cycle it is in results somewhat different from that usual in most American oil engines. The common method of fuel injection has the disadvantage that much stratification occurs, so that the mean effective power, which should be higher, because of the increased charge weight, does not come up to expectations. The Diesel, Haselwander and other Continental engines break up the fuel stream by compressed air, thus giving an intimate mixture.

With the Miller cycle the two-charge components are thoroughly mixed by the blast of air resulting from the opening of the valve *b*, establishing communication between the combustion and expansion chambers. It is to be remembered that in order to prevent a free expansion drop when the two chambers are put into communication just before dead center, the exhaust valve *d* of the expansion chamber closes, so that the remaining gases trapped therein (largely pure air) are compressed, because of the very small clearance, to a degree somewhat higher than that existing in the combustion chamber. This has the effect also of balancing the valve *b*. In fact, this phase of the cycle might be worked out to act as a timing valve with automatic ignition.

Regarding the desirability of fuel injection over the usual carburetor methods a few words might be said. For naval and commercial vessels the item of reliability will be paramount. The vagaries in fuel compounding with carburetors induced by thermometer, barometer and hygrometer changes, and the problems involved in requiring a gaseous medium, air, to conform to the laws of liquid fuels may be tolerated in pleasure service, but hardly elsewhere. It is significant that the great majority of kerosene and heavy-fuel engines used all over the world, even with ignorant help, is of the injection type. While on the subject of reliability, attention is called to the fact that with the elimination of the exhaust gases from the new charge and with fuel injection, increased flexibility and certainty of operation are bound to follow.

Semi-rotary valves are shown; poppet valves could be used just as well, but the former possess so many advantages in quietness, ease of operation and long life that it is thought, in view of the lower wall temperatures possible with this cycle, that the difficulties arising with rotary valves in the ordinary cycle will be absent here. In fact, the largest modern air compressors make use of this type of valve.

The prevailing practice with large marine and railroad engines for starting seems to be by compressed air stored in a tank and supplied by a small attached compressor. The writer has always believed that this method with its complications may be unnecessary and that the gas engine possesses in itself the means for self starting.

A mixture of gas or gasoline vapor and air ignited at atmospheric pressure results in explosion pressures, ranging from 30 to 95 pounds per square inch. If a supplementary chamber be connected to the cylinder and the entire contents of the combined volumes be ignited at atmospheric pressure, the explosion proceeding from the chamber to the cylinder compresses the unburned mixture before it (Clerk Lanchester Method) and pressures up to 250 pounds are made available.

With the carburetor system of fuel compounding, of course, when the engine stops the cylinders will be filled with mixture. But gasoline vapor not being a fixed gas, as the cylinders cool the vapor will condense out of the mixture, so that the possibilities of self starting depend upon this phenomenon. A gasoline engine should be capable of starting at any time, after stopping, so that this method is out of the question.

The Miller cycle has all the advantages and more of the Clerk Lanchester method. Instead of a supplementary chamber the expansion chamber *c* is utilized and the resulting explosion acts not only on the contracted portion of the piston, but on the the larger portion as well. The two chambers being in communication and the spark being made, it is only necessary that the gasoline be squirted in as a fine stream toward this spark. The single-crank double-acting type stops by cutting off the fuel supply, and combustion and expansion cylinders must therefore be filled with pure air, which still will be pure air a week or a month later.

The engine would hardly stop on dead center, because that would be against the full compression; in either cylinder the crank position would therefore be somewhere about mid-stroke. The resulting impulse would be amply strong to turn the engine several revolutions. Fuel injection being a positive factor, the engine must take up this cycle before one-half a revolution is passed.

Much that had been said of self starting applies to reversing. While the arrangement of the valves in the Miller engine is such as to permit easier application of compressed air, yet, as has been shown in the paragraph on self starting, the engine can be made to reverse just as positively without extraneous devices. Here, again, the expansion cylinder comes into play. The valves are operated by eccentric with a Stephenson link motion. Suppose that the engine is turning over in the forward direction, the explosion taking place in the top cylinder, and the rotation is to be reversed. The link is pushed over so that the reverse eccentric comes into action. The lower exhaust valve "*d*" is closed instead of being opened, and the upper valve "*d*" is opened instead of being closed. The upper cylinder loses its impulse, the lower cylinder traps the exhaust gases in the expansion cylinder; the motion of the engine is slowing down on an air cushion, as these gases are gradually compressed until a point is reached where the compression overcomes the forward motion.

The engine reverses by reason of this compression, aided by the explosion tripped prematurely.

Should the engine be required to start in the reverse direction after standing idle for sometime, the self-starting operation, as sketched above, is gone through with the links in the reverse position.

The pistons traveling together are connected by tie rods. To prevent leakage, long sleeves are used. These sleeves, because of their considerable length and oil packing, are very efficient and are exempt from the usual stuffing-box troubles. The tie rods themselves are lapped in the sleeves and are always in tension. They operate in the comparatively cool atmosphere of the expansion chamber. Where necessary, the sleeves could be subjected to a blast of cold air from the ejector action of the exhaust, as explained before.

As applied to naval and high-speed vessels, the absence of heavy auxiliaries, the high mean effective pressure, the frequency of impulses should result in light weight. It is not unreasonable to suppose that in large units an average weight of one pound per horse-power could be obtained.

A phase not unimportant is that with the use of pump injection the possibility of back firing in the carburetor is eliminated, with consequent lower insurance rate. Alcohol, kerosene and other safe oils operate best with pump feed, and once started with a small quantity of gasoline or alcohol alone should give no trouble.

SIXTEENTH ANNUAL MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

The sixteenth annual meeting of the Society of Naval Architects and Marine Engineers was held in the Engineering Societies Building, New York, November 19 and 20, 1908. The report of the secretary-treasurer shows that the total receipts for the year amounted to $9,756.19 (£2,003) and the disbursements, $8,305.49 (£1,705). The total resources of the society at the end of the fiscal year were $27,818.51 (£5,712), with no liabilities against it. The membership at the beginning of the year was 828. This has decreased during the year to 765, but, by the election of forty-six new members at the present meeting, the total membership is brought up to 811.

PAPERS READ NOVEMBER 19.

No. 1—The War Eagle.—1904.

BY CHARLES H. CRAMP.

Chesapeake Bay in about the first half of the last century was noted as the home of two classes of vessels known over the entire world as the "Baltimore clipper" and the "pungy." Conditions of commerce at that time were such that high-speed sailing vessels were required, and both of these types were world famous in this respect. On the Chesapeake the "pungy" was always built "by the eye." There was no model, no "laying down" or "laying off" in the mold loft, nor were molds made there from a "body plan." Each builder would have a stem and a midship-section mold for all vessels, and as there was little difference in the dimensions of the boats, these two molds could be adjusted to an increase of a few inches in depth or width to suit contract requirements.

Having built a celebrated "centerboard" schooner named the *Wood Duck*, for a party in the oyster trade in Philadelphia, another party, a rival in the same business, placed a contract with my father to build a "pungy" that would be the fastest in both bays (the Chesapeake and Delaware). This vessel, named the *War Eagle*, was the only one of her type built north of Baltimore with the exception of a pilot boat or two, and easily fulfilled the stipulation in the contract that she should be the fastest in the two bays. The sailing qualities of the boat were remarkable and she was never beaten either in a match race or when plying her usual trade.

There was but little difference in the model between the "pungy" and the pilot boat of our Atlantic ports and in general design of the "cup-defending" yachts. The fast ship, whether it was in the form of "pungy," "clipper," the "rover," or the "long, low, black schooner," was particularly an American product, and the methods in its production were born in the American shipbuilder at that time. No model in any country for form or seaworthiness has ever equaled that of fifty years ago.

The Oldest Iron Ship in the World.*

Sixty-six years ago there was dragged across the mountains from Pittsburg to Lake Erie the plates and angles, bars and beams, bolts and rivets, forgings and castings, out of which was constructed what is now the oldest iron ship in the world. This is the United States man-of-war *Michigan* (rechristened in 1905 the *Wolverine*), which since that time has continued to be the whole United States Navy on the Great Lakes, where treaty obligations restrict naval representation to one ship on each side. She was a veteran when Ericsson's *Monitor* threw all the navies of the world into the junk-pile, and was forty years old when the first ships of our so-called new navy were authorized, and they in turn have gone into the discard long years since.

She is rated as an unarmored, unprotected cruiser, with a water-line length of 165 feet; beam, 27 feet; displacement, 685 tons; indicated horsepower, 365; speed, 10.5 knots (12 statute miles); coal endurance at 10 knots, 2,240 nautical miles, or 224 hours; bunker capacity, 100 tons.

Much of our steam engineering knowledge is based upon the early experiments on expansion of steam, superheating, steam-jacketing, condensation, etc., carried out on her by B. F. Isherwood, afterwards Engineer-in-Chief, United States Navy, when attached to her. The value of those experiments, and the theories deduced from them, to the world at large, are beyond computation, and they are to this day quoted as authority. The engines are of the simple inclined type, with two cylinders 36 inches diameter, 8 feet stroke, and although of an antiquated type, their condition is stated in the Bureau reports to be good. The original paddle-wheels were 21 feet 10 inches diameter and had each sixteen paddles or buckets. The dip of the wheels was 32 inches and the maximum revolutions 22 per minute. The draft was 7 feet 8 inches. The boilers were of the "box" type, 8 feet 6 inches wide, 19 feet long, and 9 feet high, and the working steam pressure was 15 pounds per square inch. These old boilers have long since been replaced by others of a modern type, and new paddle-wheels of smaller diameter are also fitted. The draft is also increased to 9 feet, no doubt partly due to the increased boiler weights and partly to increased coal capacity, made possible by shorter boilers. But the hull and engines and most of the equipment, except armament, remain as they were built sixty-six years ago.

The *Wolverine* has not only a sentimental value but she is in active service, and she has contributed much to material progress, and as she is likely to be useful for many years to come, the most graceful thing the Department can do, the greatest compliment it can pay, not only to the old ship herself but to our neighbors across the line, is to continue her in commission.

* Discussion of paper No. 1, contributed by Henry Penton.

No. 2.—Practical Methods of Conducting Trials of Vessels.

BY COL. E. A. STEVENS.

ABSTRACT.

Speed trials outside the navy are in this country only too often carried out under conditions that render the results "painfully inaccurate." These conditions are due to many causes, but chiefly to a lack of appreciation of the value of the data to be obtained, to an exaggerated idea of the cost, and sometimes to carelessness.

Where only a limited number of runs are available the trials should be planned with care and run as systematically as possible. The apparatus needed is neither very expensive nor intricate. It should, however, be reliable. The observations, after all, can give knowledge on but three points:

1. The time on the course.
2. The revolutions—either the total on the course or the revolutions per minute.
3. The mean effective pressure in cylinders.

The record of time and revolutions should be taken simultaneously. The device illustrated in the paper by the late Naval Constructor Woodward (see Transactions of 1905), furnished an excellent means to insure simultaneous records and a very accurate registering mechanism. A device I have used for this purpose with much success consists of a contact arranged to work from the indicator-gear lever, which opens and closes a circuit at each revolution. A magnet is energized by the current, and moves a plunger against a spring which, on the opening of the circuit, forces the plunger back. This motion is recorded on a counter. The counter is started by a switch at the beginning of each run and stopped at the end; a watch held by the same observer can be started and stopped

at the same time. The result is, of course, not as accurate as the device suggested by Woodward but is much less expensive.

Stop-watches used on trials should be carefully rated. Indicators are often incorrectly rigged. Their springs should be tested. A tachometer set in plain view of the man at the throttle will enable him to maintain a constant speed, and will also furnish a check on the revolutions per minute at the time that indicator cards are taken.

A very important point is the determination of the speeds at which runs shall be made. The settlement of this depends on the system on which the results will be plotted. To properly determine a curve of speed on revolutions per minute, five spots should be had at different speeds. These spots can be obtained by the second means of three runs at each speed, or more closely by the mean of second means of four runs at each speed. This involves twenty runs, which is usually more than can be had.

If the system in use in the navy, which is based on a set of runs at evenly progressive speeds with four runs at the highest speeds, is employed, the runs must be made at evenly progressive speeds and at nearly equal time-intervals. Failure to comply with these conditions may induce considerable error.

To meet ordinary conditions the tidal formula explained in the Transactions of 1901 seems generally preferable. This formula is based on the equality of advance per revolution. Fairly accurate results can be had with ten runs and good results with twelve. Runs can be made in any order of speed provided enough pairs be made to derive tide curve. Although the use of this formula is more laborious than plotting the runs separately, the amount of labor is not excessive.

Whatever system is adopted it is well to remember that our observations are accurate only within a certain limit. That limit may, by careful observation and expensive apparatus, be reduced, but it cannot be eliminated. The error involved where ordinary apparatus is carefully and intelligently used is not material from the designer's standpoint.

No. 3.—The Influence of Midship-Section Shape Upon the Resistance of Ships.

BY D. W. TAYLOR, NAVAL CONSTRUCTOR, U. S. N.

(This paper is published in full on page 525.)

No. 4.—Further Experiments upon Longitudinal Distribution of Displacement and Its Effect upon Resistance.

BY PROFESSOR HERBERT C. SADLER.

(This paper is published in full on page 530.)

No. 5.—Further Propeller Analysis.

BY CLINTON H. CRANE.

Assuming that the law of comparison holds good for propellers, let T = thrust of any propeller; p = pitch ratio; D = diameter; R = revolutions per minute; s = slip ratio; H = the brake-horsepower required to turn propeller of diameter D with pitch ratio p and slip s; and T_1, D_1, R_1, H_1, represent the thrust, diameter, etc., for a similar propeller working at the same slip, and let S = the power factor in "Taylor's" formula.

$$\text{Then } \frac{T}{T_1} = \frac{D^4 R^2}{D_1^4 R_1^2}; \text{ and } \frac{H}{H_1} = \frac{D^5 R^3}{D_1^5 R_1^3}.$$

Let D_1 = unity and $R_1 = 100$.

$$\text{Then } T = \frac{D^4 R^2}{10{,}000} T_1; \text{ and } H = \frac{D^5 R^3}{1{,}000{,}000} H_1.$$

The variable T_1 has been obtained by Prof. Durand for a series of propellers, and also a variable which we will call w_1, or work in foot-pounds per revolution at 100 revolutions per minute for a propeller 1 foot in diameter.

$$H_1 \text{ will} = \frac{100\, w_1}{33{,}000}, \text{ and } H \text{ will} = .00000000\ 303\ D^5 R^3 w_1$$

Naval Constructor Taylor gives $H = .0093648\ D^2 V^3\ S.$

$$\text{Now } V^3 = \left(\frac{p D R (1-s)}{101\ 1/3}\right)^3;$$

$$H = .000000009\ D^5\ R^3\ p^3\ (1-s)^3\ S; \text{ and}$$

$$w_1 = 2.97\ p^3\ (1-s)^3\ S.$$

This gives an easy method of converting w_1 into S or S into w_1. As w_1 gives us a variable which is practically of the first degree, and S a variable of the third degree in terms of slip, it is preferable to use w_1. w_1 increases with the pitch ratio, with the thickness of the blade, area of the blade, and with the slip with all propellers except those of very small pitch ratio.

From a careful study of values of w for propellers of the same blade contour and blade thickness and the same slip within reasonable changes of pitch ratio

$$\frac{w}{w_1} \text{ will} = \left(\frac{p}{p_1}\right)^{3/2}$$

It will be noticed that the horsepower formula deals with the fifth power of the diameter, the third power of the revolutions and the first power of w, consequently in determining diameter from this formula a small error in w produces a very much smaller error in diameter; that is, an error of 10 percent in w would only give us an error of 2 percent in diameter.

No. 6.—Deviation of the Compass Aboard Steamships—Its Avoidance and Correction.

BY L. H. CHANDLER, LIEUTENANT-COMMANDER, U. S. N.

This paper is of such great length and treats the subject in such a complete manner, beginning from fundamental principles and outlining in detail the many different ways of compensating for the deviation of compass on board steel ships, that space will not permit an abstract which would adequately cover the subject-matter which it contains. The paper is a statement of the general mathematical principles involved, illustrated from the results of observations taken and worked out by the navigators of the vessels of our battleship fleet. As the members of the society have never given much attention to the question of the magnetic effect of the structure of a steel ship upon the compass, the author took occasion to present this paper in the hope of arousing an interest which will lead ship designers and builders to realize the necessity for a clear comprehension of the general principles involved, and the need for careful planning in arranging the details of construction of vessels in the vicinity of compass positions. A little lack of understanding or care in regard to this point on the part of the designer and builder often places the navigator, from the start, under a handicap so severe in its nature as to often constitute a real and unnecessary menace to the safety of the ship.

After briefly describing the mariner's compass and the effect of the earth as a magnet on the compass, variation of the compass is defined, and the forces acting upon a ship's compass, including the total magnetic force of the earth, and the magnetism of the adjacent members of the ship are described. Following this is a comprehensive mathematical discussion of the relation of the magnetic forces affecting a ship's compass, including the derivation of Poisson's equations. Having discussed, from a theoretical point of view, the forces which cause deviation, and having deduced certain equations concerning it, the principal practical methods employed by navigators in determining, correcting or compensating for it are considered.

First, methods of compensation of a new ship alongside a dock are available. Having obtained an approximate compensation by one of these methods, an exact compensation can be made while the ship is under way. Throughout the first method it was assumed that the sub-permanent magnetism was really permanent, but, when the ship is actually steaming at sea, this may change appreciably from day to day, especially in a new ship, as the magnetism absorbed in building "shakes out." For this reason the presence of iron near the compass is bad, not only because of the initial error it causes, but because a very small change in its magnetic condition produces a greatly exaggerated change in the compass, and so introduces a most uncertain element of danger. It is just here that the designer and builder, who appreciates the importance of these effects, can best help the navigator by changing the position of certain parts of the structure, so that they will have a less effect upon the compass.

Finally the subjects of perfect theoretical compensation for semi-circular and quadrantal deviation are discussed and it is pointed out wherein they fail in actual practice. A vast amount of valuable data on the results of the compass observations taken on board the battleships and torpedo-boat destroyers of the Atlantic fleet during its trip around South America last winter are given. There are some gaps in the data, and some results that are probably in error, as the observations were taken and the data worked up by officers whose time was fully occupied in the performance of their daily duties. Even with these omissions and errors the results are of inestimable value.

No. 7.—The Influence of Free Water Ballast Upon Ships and Floating Dry-Docks.

BY T. G. ROBERTS, NAVAL CONSTRUCTOR, U. S. N.

ABSTRACT.

This paper contains a mathematical consideration of the theories governing the various considerations of stability of a floating dock throughout its various operations. In considering the loss of stability, due to free water ballast, it is shown that the moment of stability of the ship is equal to the righting moment of the ship minus the capsizing moment, due to the free-water surface. On the other hand, it is evident that there may be an increase of stability, due to free water ballast, since the free water may swing farther to either side of the vertical than the roll of the vessel, and its action may either aid or hinder the rolling between the extreme values of the shifting moment applied positively or negatively. In a floating dock the longitudinal stability must be provided for by a sufficient number of longitudinal compartments. But usually structural considerations require a greater number of such subdivisions than necessary to compensate the longitudinal stability. The transverse stability is much more sensitive and will need transverse subdivisions for compensating the loss of stability, due to free water surface. The mathematical considerations for finding the most suitable number of longitudinal compartments of equal width, so that the metacentric height will not be materially reduced, gives some definite idea of the value of additional compartments, showing that, after a certain necessary number additional ones may be of little value.

To find the interior water depth for a given immersion, it is noted that the displacement of the dock at any draft is equal to the weight of the dock plus the weight of the water inside the dock. It is evident, therefore, that the outside waterline is higher than the inside water surface. The method of locating the corresponding positions of the two consists of plotting curves of displacement of the dock at various drafts, and curves representing the weight of the interior water corresponding to the various water-level heights. From these a curve showing the total weight of the dock and interior water for various water levels is obtained. If a ship is in the dock, the curve of the ship's displacement must be added to the curve of the dock's displacement and weight of the interior water.

A consideration of the stability of the dock requires calculations when the dock is free under all different conditions, and also when a ship is in the dock under all conditions. The mathematical discussion leads up to a formula for the coefficient of stability in which all values occurring having been obtained by direct calculation, and expressed in curves, corresponding values may be taken from the curves at any draft. The greater the weight of the ship in the dock, the less will the coefficient of stability become. As the dock inclines, the stability increases with the angle of heel with the dock free, and by a greater proportion with a ship in the dock. Therefore, the stability is a minimum at the vertical position for any probable angle of heel, and the stability curve increases as the dock inclines by righting moments greater than for the displacement cut by the ship in dock inclined at the draft of the instant under consideration.

The forces tending to bend or break a floating dock act in the same manner as for a ship considered as a floating beam. It is customary on the part of some to consider that the side walls of a dock should be built with sufficient girder strength to carry the entire load. As a matter of fact, the load rests upon the center pontoons, and is transmitted through the connections to the side walls. All portions of side walls, pontoons and connections carry each its own share of the distributed load, both longitudinal and transverse. The strength calculations, therefore, consider the entire dock as a single beam, longitudinally or transversely. From the curve of bending moments it is found that, with a ship docked and the dock pumped dry, if we introduce water into the end pontoons the maximum bending moment at the midship section will be reduced. In a certain dock it was found possible to so flood the ends with a depth of 8 feet 9 inches of water inside, and still leave enough freeboard at the pontoon deck platform. In that condition the unit stress at the most strained section was reduced to less than one-third its former value. It is therefore wise to retain as much water as possible in the end pontoons in docking a large ship where the stresses are great, especially when the ship is to remain in dock for a length of time.

No. 8.—Some Recent Inventions as Applied to Modern Steamships.

BY W. CARLILE WALLACE.

ABSTRACT.

For the safety of the crew and for convenience in working the vessel, an arrangement possessing the following qualifications by which every bulkhead door in the vessel can be closed from the bridge in a matter of a comparatively few seconds should be installed on every ship. First, it must be possible under ordinary conditions at sea or in port to open and close the doors at will, leaving them either open or shut. Second, before the doors are closed from the bridge an automatic warning must be given to those below, after which they must close slowly, not drop suddenly. Third, after the doors are closed from the bridge it must be possible to open any individual door, the door closing automatically again. Fourth, in the event of water entering any compartment to a dangerous extent, the doors in immediate proximity to this compartment must close automatically. And last, the means adopted for closing the doors must be such that even when the mechanism is submerged it will still perform its work.

Four mediums are available for doing this work: steam, air, water and electricity. Steam is inadmissible chiefly on account of bursting steam pipes. The pneumatic system has

been tried and found wanting, to say nothing of its being too expensive. Electricity has been used with considerable success in this country, but has objections, which appear to the writer to relegate it to the second place. Among them is the possibility of blowing out of fuses or injury to the motors through overload, the risk of short circuit should the gear or conductors become submerged, and the great difficulty of locating or remedying a fault in the system. For these reasons hydraulic control seems to fulfill, more nearly than any other, the requirements necessary to a thoroughly reliable water-tight door-closing system. In the writer's opinion the hydraulic system in use on the two large Cunarders fulfills every requirement of a perfect water-tight door system.

The other inventions considered tend more toward the comfort of passengers than to their safety. The first of these is the new means of disposing of the ashes and clinkers from the stokeholds of vessels without the necessity of hoisting them above the main deck and dumping them over the side; or forcing them above the waterline by a jet of water and then over the side through a bent pipe. The new method consists of an apparatus by which the ashes and clinkers are forced through the bottom of the ship by means of compressed air. The expeller proper consists of a hopper to receive the ashes and clinkers opening into a crusher, which breaks up the large clinkers. Below the crusher is a drum revolving horizontally in a water-tight casing. As it revolves the inside of the drum is alternately in communication with the chamber below the crusher, and the discharge opening through the bottom of the ship. While in communication with the latter, compressed air is admitted, expelling the ashes through the bottom of the ship.

Two other recent inventions of importance include a device for cooling state rooms in vessels trading in the tropics and fitted with refrigerating machinery, and a device for maintaining electrically-heated staterooms at a definite temperature irrespective of atmospheric conditions. The cooling device consists of a pipe containing a brine coil supplied from the refrigerator, through which the air supplied to the stateroom is drawn by a small motor-driven centrifugal fan. The other device is the Geissinger electric thermostat, by means of which electric heaters are automatically controlled to maintain a room temperature constant within the limits of a few degrees, thus saving electric energy and adding to comfort.

PAPERS READ NOVEMBER 20.

No. 9.—Service Test of the Steamship Harvard.

BY PROFESSOR C. H. PEABODY, W. S. LELAND AND H. A. EVERETT.

(This paper is published in full on page 522.)

No. 10.—Trials of the U. S. Scout Cruiser Chester.

BY CHARLES P. WETHERBEE.

ABSTRACT.

The final acceptance trials of the United States scout cruiser *Chester** took place on Oct. 20 and 21, 1908, in a heavy northwest gale, with the following results:

Duration, hours	12	4
Displacement, tons	3,800	3,630
Mean revolutions per minute	479.6	590.1
Corresponding speed, knots	23	26.1
Miles per ton of coal	2.3	1.5
Average air pressure, inches	0.75	2.75
Coal per E. H. P. per hour, pounds	3.61	3.23
Coal per I. H. P. per hour on basis of 0.55 propulsive coefficient	1.97	1.78

* For a general description of this vessel, see page 254 of our June (1905) issue, and for a record of the preliminary acceptance and standardization trials covered in the first part of this paper, see our issue for September, 1908.

On these trials in a very rough sea the turbines did not race. The ship was operated on these trials by her regular navy crew under service conditions. The coal was ordinary run of mine taken from the Government pile at the Boston navy yard. The air pressures carried were, by direction of the board, regulated to be the same as on the corresponding preliminary acceptance trials.

The conclusion drawn by the writer from the trials of this ship is, that the combination of bent-tube boilers with rugged scantlings, or of other boilers capable of a high rate of forcing and evaporation per unit of heating surface combined with steam turbines, permits a lightness of machinery installation without any sacrifice of durability and reliability never before contemplated in our warship designs. Light machinery installations have been constructed in the past for torpedo boats and destroyers, but through the use of short-life boilers of very light scantlings and delicate parts in the main engines and auxiliaries durability and reliability have been sacrificed. The machinery of the *Chester* is not of this class. Lightness per unit of power is obtained through thermodynamic efficiency and high output per unit of surface. The boilers are of rugged design and have large, thick tubes. Their casings are heavy and durable. After 14,000 mile of steaming, one small part of the casing only has shown any effect of service. A slight thickening at this spot, and the addition of four small baffles about 6 inches square in the soot-boxes at the bottom of each boiler, will remedy this difficulty. Furthermore, the boilers can readily be cleaned. These boilers can be forced to evaporate 11 to 11.5 pounds of water per square foot of heating surface under gage conditions (not from and at 212 degrees). They are not light per unit of surface, but their ability to indefinitely withstand heavy forcing and show good efficiency makes them extremely light per unit of power developed.

Machinery of the *Chester* type is perfectly suitable for our battleships and armored cruisers. Its adoption will give our country ships that are a knot faster than foreign ships of the same displacement without any increase in machinery weight. Turbines have already been adopted in our latest designs, but while boilers adopted in our latest designs are strong and durable, they are not capable of the high output per unit of surface that can be obtained from the type on the *Chester*. It seems as if this advantage were worth serious consideration.

No. 12.—Shipbuilding on the Great Lakes.

BY ROBERT CURR.

This paper gives a detailed statement of the method of procedure in building a modern lake vessel of the hopper type from the ordering of the material through the laying out, fitting up and finishing of the ship.

No. 13.—The Steamer Commonwealth.

BY WARREN T. BERRY AND J. HOWLAND GARDNER.

ABSTRACT.

The *Commonwealth*, built for night service between New York and Fall River, is 455 feet 2 inches long over all, 55 feet beam molded, 22 feet molded depth with a draft of 13 feet at a displacement of 5,410 gross tons and 15 feet at a displacement of 6,410 gross tons. The maximum designed speed is 22 statute miles per hour. Experience with propeller and side-wheel steamers, in this particular service, demonstrates that very much greater overhang of guard can be fitted to the side-wheel boat. On the *Commonwealth* 19 feet 8 inches overhang, each side of hull, was necessary to provide for the spacious saloons and staterooms demanded by the traveling public. This extreme breadth of guard is in addition a very efficient safeguard against serious damage to the hull in case of collision. The compound inclined engine with feathering wheels, as adopted, combines the ability

to stop and back very quickly, utilizes only lower hold space, which is of very little value for freight or passenger accommodation, and avoids the excessive vibration common to screw propellers in shallow draft vessels.

The propelling machinery, designed for a maximum indicated horse-power of 10,000, is composed of a double compound, inclined, reciprocating engine with two high-pressure cylinders 50 inches diameter and two low-pressure cylinders 96 inches diameter, with a common piston stroke of 114 inches connected to two pairs of cranks set at right angles. All cylinders are fitted with double poppet valves, Sickles adjustable cut-off on the high-pressure cylinders, and Stevens fixed cut-off on the low-pressure cylinders, all operated with Stephenson links controlled by a 20-inch by 24-inch steam reversing engine. Two surface condensers of cylindrical type, each containing 8,000 square feet cooling surface, are located outboard of the low-pressure cylinders, with suction pipes to two vertical air pumps 5 feet diameter by 30-inch stroke connected to the low-pressure crossheads. The wheels are of the feathering type, 33 feet outside diameter. Steam is supplied by ten Scotch boilers located five on each side, each 15 feet 6 inches in diameter by 13 feet 6 inches long, having three Morrison furnaces, 50 inches inside diameter, with a total grate surface of 937 square feet and a total heating surface of 29,340 square feet. Forced draft is supplied to closed ash pits by four blowers. The electric outfit is comprised of two 75 K. W. generators with 10½-inch by 18-inch by 8-inch engines and one 50 K. W. generator with engine 9½ inches by 15 inches by 6 inches, located in the engine room on the main deck, supplying about three thousand incandescent lights, a 24-inch searchlight on top of pilot house, an electric elevator with a capacity of 2,000 pounds, and two electric blowers for the ventilation of the aft cabins.

Particular attention has been paid to fire protection and fire-fighting appliances. All wood work throughout the cargo space, emigrant quarters, crew's quarters on the main deck, and kitchen on the dome deck, is covered with galvanized iron, fastened directly to the wood. Steel decks are fitted over the machinery space. The engine-room and boiler-room ventilators and enclosures are of steel. Two fire bulkheads are provided, dividing the vessel into three fire compartments. Suitable sliding doors are provided in the main corridors and freight space. An iron bulkhead extending entirely across the upper deck house is fitted just forward of the kitchen range. There are sixty fire hydrants located throughout the steamer, with a complete equipment of portable hose and fire extinguishers. In addition to this an independent sprinkler system is provided, connected to manifolds in the engine room on which a pressure of 100 pounds per square inch is always maintained. Supplementary to this system is a thermostat system with mercury thermostats located not over 12 feet centers with all wires run in conduit, and divided into circuits corresponding with the sprinkler circuits.

In size, magnificence and completeness of equipment the *Commonwealth* represents the highest development of this type of vessel. The contractors were the Quintard Iron Works Company, of New York, and the hull was built at the yards of the William Cramp & Sons' Ship and Engine Building Company, of Philadelphia.

No. 14.—Centrifugal Pump Fire-Boats.

BY CHARLES C. WEST.

ABSTRACT.

The fire-boat is now rapidly coming into use as an auxiliary water supply to the municipal pumping plants in cases of large conflagrations. The pressure maintained and the volume supplied by the ordinary city water supply are insufficient in extreme cases and most of the large cities are now installing the system of water mains drawing their supply directly from the water front. Suitable connections to auxiliary mains are provided where these mains lead to the river. The feasibility and practicability of this high-pressure main system have been demonstrated, and consequently, in future, higher pressures and more capacity will be required of the pumps on the fire-boat.

The development of the centrifugal pump of the multiple stage variety is comparatively recent, and the advent of the steam turbine has aided in its adoption owing to the high speed obtainable. In the boats equipped with turbines and two-stage centrifugal pumps, there has been no difficulty in obtaining higher pressures than are possible in the reciprocating pump. This pressure can be easily increased by increasing the number of stages, with no effect on the structure or working of the pump. The type of turbine used in operating these centrifugal pumps has been the horizontal impulse type. This type of turbine is more compact than the reaction turbine, and it is claimed that it can be started without being warmed up, a performance said to be dangerous in the reaction turbine owing to the liability of warping the spindle.

Two 9,000-gallon boats recently built for the city of Chicago have the following dimensions: Length over all, 120 feet; beam, 28 feet; depth, 15 feet; mean draft, 9 feet 6 inches, and a displacement of 500 tons. The main pumping and power machinery consists of two 660-horsepower Curtis turbines direct connected to 200 K. W. direct-current generators and two-stage centrifugal pumps. The generators served to provide current for the propelling motors, which are of the variable speed-reversing type. There are two pumping-generating sets in each boat, and twin screws. Steam is supplied by two two-furnace Scotch boilers, with total of 3,820 square feet of heating surface and 84 square feet of grate surface. Forced draft is provided on the closed stoke-hole system. The pumps, though usually run singly, can be compounded, and a nozzle pressure of over 300 pounds was thus obtained on a test, with a resultant capacity of about 5,000 gallons per minute.

In an 8-hour test on one of these boats, 4,800 gallons of water were discharged per nozzle per minute, or a total of 9,600 gallons for the boat. The steam consumption of the turbines per B. H. P. per hour figured out at 18.4 pounds and the coal consumption per B. H. P. per hour at 2.82 pounds.

The data obtained from the foregoing test show not only that the centrifugal pump is a more powerful and reliable machine than the old type, but also that the greater economy of the turbine outfit makes it possible to do more work with about half the boiler capacity. Comparing the water rate of these turbines with that of a high-pressure pump taking steam for almost full stroke demonstrates the fact that there is probably no boat afloat of the same size that has the same pumping capacity.

No. 15.—Sea-Going Suction Dredges.

BY THOMAS M. CORNBROOKS.

ABSTRACT.

Recently, the Engineer's Department, United States Army, have contracted for a number of sea-going suction dredges of varying sizes, ranging from 166 feet to 300 feet long, the capacities of bins ranging from 1,000 to 3,000 cubic yards. The dredged material is carried in two large bins, one forward and one aft of the machinery space. The officers and crew have commodious quarters in houses on deck and on the lower deck forward and aft. The propelling machinery consists of two compound engines, steam for which is furnished by four single-ended boilers. A very large rudder is necessary, due to the shafts being so far outboard and the extreme fullness of after body.

In operating, the dredge is kept moving forward, at a speed of about six knots, with the suction pipes dragging on the

bottom. The material is sucked up by 20-inch centrifugal pumps and discharged into bins, through pipes and distributing chutes on top of the bins. By means of gates in the bottom and sides of these chutes it is possible to distribute the material evenly. As the bin fills the water is drained off by overflows through the sides. When the bins are filled the dredge proceeds to the dumping grounds and, opening the gates in the bottom, drops the material. The gates are operated by means of a double-cylinder vertical engine through worms and fixed nuts on vertical rods. The percentage dredged depends on the quality of material and ranges from 10 to 60 percent.

The curves of bending moments, etc., and equivalent girder, for the latest New York harbor dredges show that the neutral axis of the girder is very low, showing that the material is not distributed to the best advantage. The tension is the sheer strake works out at 4.22 tons and compression in the keel at 2.73 tons.

On two dredges, built for the Isthmian Canal Commission, the deflection under load measured 5/16 inch in 200 feet. This returned to within 1/16 inch of original marks when the load was dumped, which would indicate that the structure is amply stiff.

An inclining experiment conducted on these dredges gave the following results: Empty, $G.\ M. = 7.19$ as inclined, trans. $B.\ M. = 20.4$ feet, trans. $C.\ B. = 5.53$ feet, $C.\ G.$ above base $= 18.74$; loaded, corrected $C.\ G. = 18.14$ feet, met. above base $= 20.8$, $G.\ M. = 2.66$.

No. 16.—The British International Trophy Race of 1908.

BY W. P. STEPHENS.

ABSTRACT.

The modern speed launch which has of late engaged the attention of sportsmen, yachtsmen and engineers, is essentially a French production, representing a certain stage in the development of the gas-engine intermediate between the automobile and the airship. Its origin is due neither to the naval architect, the marine engineer nor the yachtsman, but to the restless and ambitious builders and owners of automobiles, who, about 1900, transferred the lightest and most powerful of their new engines from their proper place in the car to an improvised setting in some sort of a launch hull. The international auto-boat race of 1908 is noteworthy in that it has established an authentic record of a higher speed than ever before made by vessels of under 40 feet extreme length; but what is of far greater importance is the fact that it has demonstrated beyond question the position of the naval architect as the one controlling power in the production of a perfect vessel, even the marine engineer, essential as he is, being subordinate to him.

The race was held in Huntington Bay, Long Island, Aug. 3, over a triangular course 10 nautical miles long, three circuits of the course being made. The entries included two English boats, the *Wolseley-Siddeley* and *Daimler II.*, and three American boats, the *Dixie II.*, the *U. S. A.* and the *Den II.* The *Dixie II.* was first over the line, followed by the *Den II.*, the *Daimler II.*, the *Wolseley-Siddeley* and the *U. S. A.*; the last 41 seconds after the signal. Shortly after the start the *Daimler II.* speeded up and opened several lengths between her stern and the *Wolseley-Siddeley*, passing the first mark only about 20 seconds after the *Dixie II.*; a little later, however, one of her wing engines gave out and she withdrew. The *Dixie II.* covered the first round of 10 nautical miles in 21:35, leading the *Wolseley-Siddeley* by 47 seconds. She covered the second round in 22:16, with the *Wolseley-Siddeley* but 16 seconds astern. On the second leg of the third round she speeded up, finishing the race with a lead of 33 seconds.

On the following day the *Dixie II.* was run over the measured mile course in Hempstead Bay, really 1.1 nautical miles, four runs being made. The mean of the four runs showed a speed of 31.05 knots, or 35.75 statute miles. On Aug. 20, 21 and 22 the *Dixie II.* raced as one of the challengers for the A. P. B. A. Gold Cup over the Chippewa Bay course on the St. Lawrence River, two rounds making 30.10 statute miles. She won the three races, all run in rough water; the highest speed made being an average of 31 knots in the second race.

While the success of the *Dixie II.* was due to the harmonious efforts of the designer, builder, captain and engineer, the fact that concerns us most to-day is that the master mind was that of the naval architect (Mr. Clinton H. Crane); the others, each doing his own work in his own place, being subordinate to him. It cannot be too strongly emphasized that what has brought success in this instance is not the mere refinement of lines through tank experiments nor the discovery of any new principle that will make possible a higher speed; it is only that, for once at least, the naval architect has been free to exercise the proper functions of his office; to determine from his knowledge of the rules and conditions of this special case the type and general dimensions best suited to them; to select freely, according to his knowledge of the laws of naval architecture and his personal experience with vessels in service, the vital elements of the design, the displacement, freeboard, location of the centers and distribution of the weights; to draw upon his general knowledge of marine engineering for a horsepower fitted to his hull, and then to utilize his special knowledge in the drafting of the lines.

No. 17.—Transportation of Submarines.

BY NAVAL CONSTRUCTOR W. J. BAXTER, U. S. N.

ABSTRACT.

It having become necessary to transport two submarines, length over all 64 feet 9 inches; diameter, outside of hull, inside of bilge keels, 11 feet 10 inches, it was decided to send from the Navy Yard, New York, to a distant port on a collier, length over all 322 feet, breadth extreme 43 feet, depth molded 23 feet 1¾ inches, normal load draft 19 feet 7½ inches, and launch them from the collier's deck upon arrival at the port of destination, after which the collier was to be ready to immediately assume her ordinary duty.

The necessary stability calculations, to determine: first, the stability conditions when the collier was properly loaded with a large cargo, and with the submarines on board; the various changes in water ballast which should be made during the voyage to compensate for the changes in trim and draft which would follow the consumption of coal en route to ensure that, under all possible conditions of weather, the collier would be kept in proper trim, with ample stability; and the provision of suitable additional local strength to prevent any possibility of racking or straining the hull, so as to cause leakage through seams, butts and rivets, or of straining the submarines. This having been satisfactorily determined, the actual working plans were next prepared; but before they were finally completed, a model of a submarine to three-quarter inch scale was made and given a metacentric height corresponding to that of the actual submarine at the time of launching; various model cradles were also tried, and the model was launched into a wooden tank of suitable size to prevent reflex wave action, under various conditions of trim, and under various conditions of inclination of the collier, and, finally, in imitation of the gradual change in the slope of the ways which would occur owing to the shifting of the weights during the launching period. These experiments having fully confirmed the calculations, working plans were prepared with a view of placing these two submarines on the starboard and port sides, respectively, of the collier's after-well deck, their midship sections being approximately abreast the mainmast,

and their axes being placed directly over the outboard coamings of the coaling hatches, and parallel to the bottom of the keel.

The launching ways and the tripping devices were of practically the same type as those usually used in launching sideways, with this difference: that four launching ways and cradles were used, two at each end, each pair being so tied together that they acted as sleds, and, between them, three supporting chocks were located over bulkheads and beams beneath. The entire weight of each submarine was therefore carried on four heavy cradles and three solid chocks, the cradles being so arranged that they would carry their proportion of the weight. The three supporting chocks were so arranged that, at the time of launching, they could be wedged to take all the weight, and permit the removal of the cradle sleds for the purpose of lubricating the ways; they were afterwards to be replaced, and the chocks then knocked down, leaving the entire weight of the submarine on its two cradle sleds, ready to let go, by cutting one rope, at the proper time.

The submarines themselves were prepared for shipment by removing all small portable fittings, the storage battery, and the rudders; the engines were suitably shored, to prevent any racking while in transit; the propellers were not removed.

LARGE GAS ENGINES FOR SHIPS.

BY E. N. PERCY.

Gas producers for use on shipboard have been pretty thoroughly discussed, also the limits of sizes for gas engines, but all of these arguments have presupposed the present type of slow speed, high initial pressure, explosive engine. While the gas producer is getting to be fairly well understood, let us see if some more suitable type of engine could not be considered. We will assume a two-cycle, three-cylinder, fuel-injection engine as the coming type, for reasons detailed below.

Being two-cycle and three-cylinder, it can run at a high speed and be very light, for its power; especially as the fuel-injection type has no explosion, but a constant burning. This type starts easily with compressed air and reverses like a steam engine; in fact, handling just as easily. It would be a very simple engine, without gearing or valves, excepting a very small Stevenson link motion to control the fuel injection and air for starting.

The most successful engines of this type now manufactured exhaust at the end of stroke through a port in the cylinder at one side, receiving the new charge through a port in the opposite side. The new charge is air only, and thoroughly scavenges the cylinder, some of it even escaping to make a clean scavenge; but this represents no loss of fuel, and a loss of power so small that it could not be measured. After compression, on the beginning of the return stroke, fuel (gas or liquid) is injected and burns, not explodes, until cut off by the valve gear. The fuel is ignited in any one of several ways; i. e., high compression, continuous electric spark, red-hot metal or torch. The certainty and the control of these features will be apparent to any one, and, moreover, they are borne out in practice. In addition to this, we may borrow the idea from a well-known make and use the latent heat of the jacket water by letting it boil in the jacket, and after a pressure has accumulated, inject the steam into the cylinder with the fuel, where it acts in such a manner (as we know from fact, not theory) as to increase the economy and saves most of the jacket heat. The engines now on the market, made along the above lines, hold the records for economy, without exception, and in two instances have exceeded the ordinary engine by half; i. e., they take half the fuel. It might be well to notice here that the fuel-injection type of gas engine can be governed as accurately as a steam engine; in fact, could be governed by a steam-engine governor, fly ball or shaft.

Assuming this to be one of three engines, driving a large triple-screw ocean steamer, let us consider the auxiliaries. First, there should be an independent gas engine, driving a small air compressor for starting purposes. There should be a large reservoir, holding considerable air, sufficient for several manoeuvers, and a smaller reservoir, in case it has to be filled quickly for use. There will be an independent electric-light plant, run by small gas engines, to furnish power and light, and possibly ignition for the main engines. As it is very desirable to have the bearings and pins of a large marine engine perfectly accessible at all times, we could not expect to compress the charge of air in the crank chamber, since it is to be all open. Instead of adding a huge low-pressure blowing engine, we will merely have a small high-pressure electric blower, as two or three pounds is sufficient pressure. The fuel pump or small compressor, if gas is used, will be coupled direct to the main shaft, as the fuel is never needed until after the engine starts, but if the engine is very large, a small drum to store the gas under pressure may be used in conjunction with a separate auxiliary compressor, insuring always a supply of fuel to start on.

All the auxiliaries should be electrically driven, not only to do away with piping, but so that they can then be run from the dock by merely connecting with the dock power house, leaving the ship clear for repairs. All pumps will be electric centrifugal, as this type has been successfully used for feed pumps, and indeed for hydraulic pressures as high as 700 pounds per square inch.

With a ship of this description, very few firemen would be needed. There would be no more "cleaning fires," no more boiler repairs and no more stuffing boxes. The ship could be started at a minute's notice, without waiting to "steam up," or even "warm up." Instead of compressed air, it might be found advantageous to have a large dynamo on the forward end of each main-engine shaft for developing power for the auxiliaries, the dynamos being used as motors, instead of compressed air for getting under way.

Steam from the jackets, or even generated in a small boiler, could be used for heating the ship.

The writer believes that it will be very hard indeed to increase the power of marine gas engines of the explosive type, but the fuel-injection type can be designed very much as steam engines, because their initial pressures are not high (excepting the compression-ignition type) and there are no explosions, hence no necessity for the enormously massive construction of the aforesaid type.

Furthermore, gas-engine designers do not seem to appreciate the advantages of multi-cylinder types, combined with high speed and several units; and naturally, when they try to put large power, and explosive power at that, in one large cylinder, that cylinder has to be very massive and very well supported, and experience shows the repairs to be more on this type than on a multi-cylinder engine of the same power and moderately fast speed, particularly if the latter engine is a single-action two-cycle engine, because the pressures are all in one direction, and there is no knocking of parts, no matter how loose they are.

The preparations which are being made in the Belfast yard of Harland & Wolff for the building of the new White Star liners *Olympic* and *Titanic* of 60,000 tons displacement, include the construction of two new 1,000-foot building slips, over which an immense double gantry is being erected, the erection of a large floating crane and the installation of a modern electrically-driven hydraulic and pneumatic plant, at a total cost of £400,000 ($1,946,600). This work will be completed in January.

INTERNATIONAL MARINE ENGINEERING

Published Monthly at

17 Battery Place New York

By MARINE ENGINEERING, INCORPORATED

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President

E. L. SUMNER, Secretary

and at

Christopher St., Finsbury Square, London, E. C.

E. J. P. BENN, Director and Publisher

HOWARD H. BROWN, Editor

Branch Offices { Philadelphia, Machinery Dept., The Bourse, S. W. Anness. Boston, 170 Summer St., S. I. Carpenter.

Entered at New York Post Office as second-class matter.

The edition of this issue comprises 6,000 copies. We have no free list and accept no return copies.

Discussion of the Papers Read before the Society of Naval Architects.

As this meeting was not held until after our date for going to press, we are unable to publish a resumé of the discussion which took place at the meeting, as has been our custom in the past. Several important points were brought out, however, which are worthy of comment.

Three of the papers dealt with the important subject of trials of vessels, one being of a general nature, setting forth the practical difficulties of obtaining reliable trial data from merchant ships; and the other two presenting data taken from tests of turbine-propelled ships. Of the latter, one contained the results of a six-hour test under service conditions on a merchant ship, and the other, data obtained on the regular preliminary and final official acceptance trials of a scout cruiser; this data, of course, being obtained under the usual conditions which govern trial trips in the navy.

It rarely happens that the results of speed trials of warships are open to question. The trials are always carefully made under the best of conditions by a corps of trained observers, and include, of course, progressive trials over the measured mile, a four-hour run at maximum speed, and one or more twenty-four-hour endurance runs at lower speeds. On the other hand, it is seldom that speed trials of merchant vessels are as carefully made. Although there are four Government trial courses on the Atlantic coast and two on the Pacific coast available for shipbuilders and owners, frequently the only tests attempted on merchant ships are those made under service conditions, where little opportunity is given the observers to make their observations in a satisfactory way, and, therefore, the refinements and completeness which can be obtained in the case of naval vessels cannot be expected.

This point is well illustrated in the paper already mentioned, which described a six-hour service test on a merchant ship. This test was made on one of the regular runs of the vessel, and was necessarily of short duration. Due to the deplorable reluctance of the builders of the vessel to make public the details of the hull and machinery and the impossibility under the exigencies of a service test of employing the most accurate and refined methods of measuring the coal and water consumption, the results, even though worked out under the personal supervision of a well-known authority on marine engineering, were subject to considerable criticism and doubt.

The method of obtaining the amount of coal burned by counting the number of buckets is, of course, open to question, but, in this particular case, a valuable check on the results was available in the records of the steamship company for the average coal burned per trip on the steamer for the entire season. From May 11 to November 8 the ship made 178 trips between Boston and New York, partly over a course 298 nautical miles long, and partly over a course with a length of 326 nautical miles. The average coal burned per trip was 106.5 tons, 12.5 tons being estimated as the consumption while in port. This figures out as 7.1 tons per hour, which checks exactly with the estimate obtained in the test.

The equivalent evaporation of the boilers from and at 212 degrees, figured out at 11.2 pounds, which, while not impossible is exceptionally high, and as many instances are on record where water meters have been known to give erroneous results, sometimes with a percentage of error as high as 17, the question was at once raised not only as to the accuracy of the determination of the coal consumption, but also as to the reliability of the water meter. In the present case, the meter was especially designed to handle water at the temperature of the feed, and careful calibration under the exact conditions existing during the test showed a difference of only one-half of one percent before and after the test, so that the figures for the water consumption cannot very well be doubted.

The value obtained for the shaft horsepower of the

turbines was criticised mainly because the value for the modulus of elasticity of the shafts was assumed instead of being determined exactly. This would not be admissible if there were any reason to believe that the modulus of elasticity would vary within wide limits. But it is well known that for different pieces of steel of the same properties this value varies very little. The value 14.76, obtained for the steam consumption of the turbines per shaft horsepower per hour seems, of course, at first sight to be somewhat larger than might be expected. It should be noted, however, that in this value no account has been taken of the four percent priming in the steam. Taking account of this priming and reducing the steam consumption per shaft horsepower to steam consumption per indicated horsepower on the assumption that the shaft horsepower is between 85 and 90 percent of the indicated horsepower, we find that the steam consumption per indicated horsepower per hour would be about 12.5 pounds, which is by no means a bad showing for either a reciprocating or turbine engine.

The value of model tank experiments in settling doubtful points relating to the resistance of ships was again demonstrated this year by the results of experiments performed by Naval Constructor Taylor at Washington and Professor Sadler at the University of Michigan. The influence of a change in the shape of the midship section of a vessel upon its resistance has hitherto aroused much speculation. As a result of Mr. Taylor's experiments, designers can now be reasonably sure that, for a midship section of definite area, the shape can be varied without affecting to a great extent the resistance of the vessel. The few experiments which had hitherto been made on models with a fine midship section and a full midship section seemed to indicate that the full model would drive easier. This has now been shown to be true, and a section with a flat bottom and deep bilge can be expected to give better results than one in which the draft is increased and a comparatively fine section used. Of course, it is not always expedient to use a broad section, for in sea-going ships increased draft is frequently necessary to insure proper sea-going qualities. In connection with a broad, full midship section hollow bow lines seem to be an advantage.

Hollow bow lines do not necessarily cause excessive pitching, because that is largely due to synchronism. In one particular case where two models of English warships were tested, one with hollow bow lines and the other with straight lines, it was found that an advantage of one knot in speed could be gained by the use of the hollow lines.

Attention was called by one paper in particular to a type of ship which is distinctly American. This paper described in detail the latest addition to the fleet of shallow-draft paddle steamers operating on inland waters. This boat, which is only 455 feet 2 inches long over all and 55 feet wide, with a maximum displacement of 6,410 gross tons, at which the draft is 15 feet, has accommodations for as many passengers and as much freight as the giant Cunard steamship *Lusitania*, which has a gross tonnage of 30,822, a maximum draft of 37½ feet, and is 785 feet long over all, with 88 feet beam.

The problem of building a boat which is in reality a six-story floating hotel for such a capacity and upon such small draft is certainly noteworthy. Nothing is sacrificed on boats of this type which will add to the comfort and safety of the traveling public, so that, in completeness of equipment and luxurious appointments, these ships compare favorably with the finest ocean liners. The problem of propulsion in ships of this kind is of the utmost importance, and, for reasons of both economy and convenience, the paddle steamer has never been superseded by propeller-driven ships, even though the introduction of steam turbines has tended to reduce the diameter of propellers and decrease the vibration.

Fuel for Internal Combustion Engines.

Many tests of internal combustion engines have been made, but a large majority of them have been made by private concerns for a specific purpose, and the results are not generally available. Furthermore, as is generally recognized by those familiar with gas engines, especially those operating with gasoline (petrol) as a fuel, the conditions influencing engine performance are so numerous, and vary to such an extent, as to make the value of off-hand comparison very limited, and, oftentimes, misleading. Exact comparisons are only possible under identical conditions, or when the actual differences in all conditions that influence the results are exactly known. With a view to obtaining comparative results, which would be of value concerning the operation and design of gasoline and alcohol engines, the Technologic Branch of the United States Geological Survey has recently made an exhaustive investigation, the results of which are published elsewhere in this issue.

The work was taken up to investigate the characteristic action of fuels used in internal combustion engines, with a detailed study of the action of each fuel (gasoline and alcohol) as governed by the many variable conditions of engine manipulation, design and equipment. These variables, so far as possible, were isolated; their separate and combined effects were determined and worked out under practical operating conditions, leading up to the conditions required for minimum fuel consumption. The results show the saving that can be obtained for conditions over maximum consumption and also establish a definite basis of comparison under conditions most favorable to each fuel. This latter is a point of much commercial interest, and, undoubtedly, this study of the comparative action of gasoline and alcohol will be of great service in solving some of the general internal combustion engine problems where other than liquid fuels are used.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

	Tons.	Knots.		Oct. 1.	Nov. 1.
BATTLESHIPS.					
S. Carolina..	16,000	18½	Wm. Cramp & Sons........	63.2	65.9
Michigan ...	16,000	18½	New York Shipbuilding Co..	71.4	74.9
Delaware ...	20,000	21	Newp't News S.B. & D.D. Co	44.2	50.3
North Dakota	20,000	21	Fore River Shipbuilding Co.	51.2	58.8
TORPEDO BOAT DESTROYERS.					
Smith	700	28	Wm. Cramp & Sons.........	53.8	57.5
Lamson	700	28	Wm. Cramp & Sons.........	52.1	56.2
Preston	700	28	New York Shipbuilding Co..	49.1	52.0
Flusser	700	28	Bath Iron Works...........	26.1	33.0
Reid	700	28	Bath Iron Works...........	26.0	31.6
SUBMARINE TORPEDO BOATS.					
Stingray	—	—	Fore River Shipbuilding Co..	58.7	62.3
Tarpon	—	—	Fore River Shipbuilding Co..	57.3	60.2
Bonita	—	—	Fore River Shipbuilding Co..	55.5	57.8
Snapper	—	—	Fore River Shipbuilding Co..	55.7	56.5
Norwhat	—	—	Fore River Shipbuilding Co..	50.9	52.3
Grayling	—	—	Fore River Shipbuilding Co..	50.7	52.0
Salmon	—	—	Fore River Shipbuilding Co..	50.3	51.3

ENGINEERING SPECIALTIES.

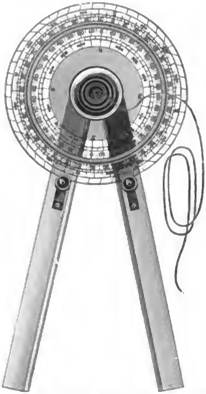
The American Inspector's Outfit.

This outfit, which is manufactured by the American Steam Gauge & Valve Manufacturing Company, Boston, Mass., consists of a 3-inch test gage of 300 pounds' capacity, a screw test pump, a hand puller, a hand set, pliers and screwdriver. All

of the instruments are nickel-plated and packed in a morocco velvet-lined case, the total weight of the outfit being about 6 pounds. Thus it can be easily carried about and is always ready for use. The outfit is especially designed for a portable testing apparatus for testing locomotive and other boiler gages, and meets the requirements of government, power plant and boiler insurance inspectors.

Captain Ashe's Patent Course and Position Finder.

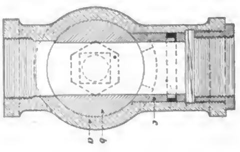
Accuracy, simplicity and strength are fundamental requirements for navigators' instruments. The fulfillment of these requirements has been sought in Capt. Ashe's patent course and position finder, manufactured by Heath & Company, Ltd., Crayford, London. This is a new chart instrument, by means of which many arithmetical calculations hitherto inseparable from chart work are entirely obviated, while in addition it is useful for the following purposes: Finding the ship's position from course bearings of two or three objects by simple



compass observation; finding the true and magnetic courses simultaneously; finding the course by observation when the deviation is known, and laying off the course without reference to the compass-croses on the chart. It is claimed that the simplicity of the instrument and the ease with which it can be manipulated render errors in courses or bearings impossible, and also permit a frequency of use which would not be justified with more elaborate and more expensive instruments. The instrument is transparent throughout, so that all details of the chart can be observed. It has been invented by a practical mariner and is intended for the use of practical mariners.

The Caskey Valve.

A new and unique valve, which can be used for several purposes, has recently been placed on the market by the Caskey Valve Company, Philadelphia, Pa. The valve may be used as a boiler blow-off valve, a hydraulic-operating valve, or as an air and relief valve. It is designed to maintain a pressure up-



to 10,000 pounds per square inch, and becomes more effective as the pressure is increased. Of course, the valve is made in different weights and in slightly different form for the various purposes for which it may be used; but in all cases the valve is a straight-through valve, with no pockets or recesses. Furthermore, there are no stuffing-boxes, valve seats and, consequently, no fluttering action. The illustration shows a sectional view of the boiler blow-off valve. It consists of the body, *A;* straight plug, *B;* the bushing, *C,* ground to fit the plug, *B;* while to assure contact between *B* and *C* a spring is provided. The valves are made in sizes ranging up to 6 inches.

The B. & S. 15-Degree Angle Motor Boat Wrenches.

The Billings & Spencer Company, of Hartford, Conn., are putting out a new set of 15-degree angle double-end wrenches that are adapted to use on motor boats, etc. These wrenches,

seven in number, ranging from 7/16-inch milled opening to 1¼ inch, are put up in serviceable waterproof kit bags of duck or drill, and are furnished either semi-finished or with a full case-hardened finish. This should prove a very convenient set of tools for general use aboard a motor boat.

Oster Matchless Die Stock.

The Oster Manufacturing Company, of Cleveland, Ohio, has recently brought out a new tool for threading pipe. This is a die stock for pipe ranging in size from 1 to 2 inches in diameter. The dies are controlled by a cam, which, following the lead screw, is driven by a guide post at the exact taper for pipe thread. The dies automatically recede to make a standard taper thread. Standard size is obtained by setting

the guide post in position to indicate the size as graduated on the face plate, and locking the die solid by the nut at the bottom of the post. This setting remains unaltered as long as duplicate threads are desired. Over or under-size threads, or crooked threads, can be obtained if desired, and one set of dies may be used for all sizes or a set for each size, as the operator prefers. An important feature is the universal gripping chuck, which adjusts to all sizes by revolving a handle; this takes the place of all bushings and makes the stock entirely complete within itself. There are no loose parts, and as the gripping jaws are of tool steel, hardened, it is claimed that they will effectually withstand the strain and wear.

TECHNICAL PUBLICATIONS.

The Mechanical Engineering of Power Plants. By Frederic Remsen Hutton, E. M., Sc. D. Size, 5¾ by 9 inches. Pages, 825. Figures, 697. New York, 1908: John Wiley & Sons. Price, $5.

A former edition of this book, issued in 1897, embodied the study and experience of the author, gathered during the previous twenty years, and brought together for teaching purposes. Due to the fact that the years since then have been a period of great and rapid progress in the development of the power plant, and of engineering departments pertaining to it, it has been found necessary to rewrite the entire book. The present edition is the result of this work.

The new features which are specially noteworthy are the analysis of the power plant and its diagram; the separation of the simple and complex phases of this problem; the treatment of the steam pipe as an element of co-ordinate importance in the plant with the boiler and engine; the chapters on the auxiliaries as distinguished from the essentials; a discussion of the steam turbine; the establishment of the philosophy of the expansion of the elastic medium as the basis for the valve gear, the governor, the condenser and the compound engine. Statistics and tables have been very largely excluded, it being the intention of the author that engineers' pocketbooks should be consulted for this information.

The main headings under which the subject is treated are the quantitative basis of the steam-power plant, leading up to the cost of a horsepower; a comprehensive treatment of the steam boiler, including all its accessory apparatus, care and management, piping, etc.; an equally complete treatment of the engine, including a description of the design of the ordinary reciprocating engine, the rotary engine, steam turbine, valve motions, governors, condensers and auxiliary apparatus. Considerable space is given to the care, management and testing of boilers, engines, etc.

Taken all in all, this is undoubtedly one of the most complete and valuable works covering the steam-power plant which is available for engineers to-day.

The Temperature-Entropy Diagram. By Charles W. Berry. Size, 4¾ by 7¼ inches. Pages, 299. Figures, 109. New York, 1908: John Wiley & Sons. Price, $2.

Students of thermodynamics are usually puzzled about the true significance of entropy, and frequently fail to realize the usefulness of the temperature-entropy diagram. This is the only book, so far as we know, which is devoted exclusively to the subject, presenting it in a clear and available manner. The subject matter has been gathered in an effort to bring together in logical order certain information concerning the construction, interpretation and application to engineering problems of the temperature-entropy diagram which is not readily accessible. An exhaustive treatment of the subject has not been attempted, but the graphical presentation of the subject given is such as to make clear the fundamental principles of thermodynamics.

The present volume is a revised edition, the first volume having appeared in 1905. A graphical method of projecting from the pressure volume into the temperature-entropy plane has been elaborated for perfect gases and its application to hot-air engines and gas engines given. The various factors

affecting the cylinder efficiency of both gas and steam engines are thoroughly discussed. One chapter is devoted to the thermodynamics of mixtures of gases and vapors, and another to the description and use of Mollier's "Total Energy-Entropy Diagram."

Fighting Ships, 1908. Edited by Fred T. Jane. Size, 12 by 7½ inches; numerous illustrations. London, E. C., 1908: Sampson, Low, Marston & Company, Ltd. Price, 21s.

Since this is a book which has appeared annually for the past eleven years, its general scope and arrangement are well known to naval men in nearly every country. Aside from the changes which occur in the subject matter, as the result of changes in existing warships and the addition of new ships to the various navies, several important changes have been made in the manner of compilation and methods of presenting data. In the previous volumes, while official classifications have been generally adhered to, the ships in any particular class have been roughly arranged according to fighting value. In the present volume this arrangement has been discarded in favor of a strictly chronological one. That this is a fair classification is evident when it is considered that recent ships, even if of inferior displacement and gun power, are of much greater value, due to the modern fittings, gun mountings, electrical gear, etc., which are installed. Furthermore, defects which exist in older ships have been remedied in the newer types. Official classifications have been strictly adhered to, for the reason that while some ships, such as the British *Invincible* class, are more powerful than most battleships, yet they have not been classed as such any more than the *Dreadnought* has been classed as a cruiser, as she might well be, because she has a higher speed than many cruisers.

Part I., which comprises all important data regarding every warship in the world, together with illustrations and diagrams, is arranged by navies in the order of their importance. This is the customary arrangement of the book, but this year the order has changed, so that while Great Britain and the United States are first and second, respectively, France has dropped to fifth place, with Germany and Japan third and fourth, respectively. Italy is placed sixth and Russia eighth.

Among the articles in Part II., dealing with various phases of warship construction, is an article describing a new type of conning tower for large battleships by Commander Hovgaard, of the Royal Danish navy, now professor of warship design at the Massachusetts Institute of Technology; an article on the future 20,000-ton warship, by Col. Cuniberti, of the Royal Italian Corps of Naval Constructors, who may be called the father of the *Dreadnought* type of battleship. Marine turbines are thoroughly discussed, drawings being shown of both the Parsons and Curtis types. Various types of watertube boilers used on warships are also illustrated and described, and in an article on the "Progress of Warship Engineering," such subjects as turbine performances, torsion meters, steam generators, superheating, liquid fuel, internal-combustion engines, ventilation, valves, torpedo-propelling engines and wireless telephony are thoroughly considered.

Silhouettes of merchant ships over 5,000 tons gross and 18 knots speed are given, as well as a merchant index, in which is listed every merchant ship of any importance which might be met upon the high seas.

Valve Setting. By Hubert E. Collins. Size, 6 by 9 inches. Pages, 209. Figures, 200. New York, 1908: Hill Publishing Company. Price, $2.

Practical instructions in the setting of valves for all kinds of engines are a necessity for supervising, operating and erecting engineers. Such instruction, secured principally from the builders or erecting men, who are familiar with the practical work involved, has been brought together in this book, the subject matter of which has been published in various issues of *Power*. Careful discussion of the slide valve is given in the first few chapters, as the principles involved in setting slide valves are fundamental. This is followed by a consideration of the Meyer cut-off valve and various types of Corliss valve gear. General rules are given for finding crank and eccentric centers which can be applied to any make of reciprocating engine. It is intended that after the reader has mastered the details in the first few chapters of the book, he will be able to read understandingly the remaining portions, which are devoted to a description of the valve gears of the most important commercial types of steam engines now on the market. In the last two chapters valve setting for duplex pumps and air compressors is described.

Patents as a Factor in Manufacturing. By Edwin J. Prindle. Size, 5 by 7½ inches. Pages, 134. New York, 1908: *The Engineering Magazine*. Price, $2.

This volume is not intended to give the inventor or the manufacturer sufficient information so that he may act as his own patent lawyer, but it is intended rather to convey an idea of the nature of a patent, the protection it may afford, the advantages it may possess for meeting certain commercial conditions, the safety which may be secured in relations between employers and employees, and the general rules by which the courts will proceed in upholding a patent and in thwarting attempts of infringement. It is intended to give the inventor or manufacturer a grasp of the fundamental principles, so that he may proceed rightly in the early steps which are usually taken before the advice of counsel is secured, after which it is pointed out when and where it is necessary to call in expert legal advice. The author of the book, as the result of wide practice, both in mechanical engineering and in patent law, is in a position to appreciate the important points of this subject, and place them before the reader in such a way that the precautions which should be taken in the preliminary steps, and the rules and principles which should be followed, are made clear. The book includes the following chapters: Influence of patents in controlling the market; subject, nature and claim of a patent; what protection a patent affords; infringements; patenting new products; patent relations of employer and employee, and contests between rival claims to an invention.

QUERIES AND ANSWERS.

Questions concerning marine engineering will be answered by the Editor in this column. Each communication must bear the name and address of the writer.

Q. 419.—The figures which you published in your January, 1908, issue in connection with a test on the steamship *Governor Cobb* have been questioned at a recent meeting of the Marine Institute. Are these figures thoroughly reliable? B.

A.—The figures for both the steam consumption of the turbines and the water evaporation of the boilers were severely attacked at the meeting of the Society of Naval Architects, at which the paper was presented. The builder of the boilers and vessel questioned the steam consumption of the turbines, as he claimed the evaporation of the boilers was too high. The evaporation figures out, allowing for the proper percent of moisture, 10.85 pounds of water per pound of coal from and at 212 degrees. The boilers of the *Lusitania* show an evaporation of 11.1 and 10.9 pounds, and in a recent test made on the steamship *Harvard*, where every possible precaution was taken, a slightly higher figure was obtained. Considering that the *Cobb* used cold air for forced draft, the 10.85 seems to be too high a figure. The method of determining coal on that test, by counting buckets, is, of course, always open to question, and is undoubtedly subject to an error.

Just what this error may be you can judge for yourself, but there is every reason to believe that determining coal in this manner will give too small a figure. There is every reason to believe that the water meter used in determining the feed-water gave very accurate results. The meter was calibrated by the manufacturers before leaving their works, and was calibrated at the Institute of Technology after the test was made. The fact that a curve of meter readings, plotted at ten-minute intervals, follows exactly the fluctuations of power, is a pretty strong indication that the readings of the meter were not sensibly in error. The only other thing that could affect the water rate would possibly be a leak in the feed-water heater, but when it is remembered that this test was run on the second round trip, after the boat had been thoroughly overhauled for its season's work, and the feed-water heater pronounced in perfect condition, the chances that it sprung a leak in so short a time are rather remote. If the determination of coal on the *Governor Cobb* were, let us say, 4 percent too low, the equivalent evaporation would then have been about 10.4 pounds, a good but by no means impossible figure, the ratio of heating to grate surface being over 37 to 1.

The figures for steam consumption do not appear to be at all favorable from an economical point of view, but it is a well-known fact that the *Cobb* in actual service uses vastly more coal than was expected. L.

Q. 420.—Are licensed officers required on pleasure motor boats? What equipment is required on such boats? NEW YORK.

A.—No licensed officers are required on any pleasure motor vessel, no matter how large she may be, and if the boat is under 16 tons it does not have to be documented at the custom house. Licenses are held by the operators of a good many pleasure motor boats, who wish occasionally to earn a few dollars by taking passengers for hire, taking parties to the Fishing Banks, or leasing their boats for a day or two. Motor-driven fishermen, oystermen, etc., are also exempt from inspection, and do not require licensed officers. This creates a great danger in passenger business, as some boats are registered as oystermen, but never do anything but passenger business, and probably a large majority of the boats which ordinarily are oystermen take out fishing parties for hire on Sundays and holidays. In the Second District upwards of 3,000 licenses have been issued to operate passenger motor boats of 15 tons or less, while there are not in this district 100 motor boats documented as passenger boats, showing that the great majority of these operators call their boats either pleasure, oyster or fishing vessels, although a great many of them are not documented at all.

As to the equipment which is required on these boats, there is no law which in so many words says that everybody aboard such pleasure craft shall be provided with a life preserver, but as this is such a common-sense requirement, and is required on all commercial vessels, and as yachts are made subject to certain portions of Title LII. of the Revised Statutes, and as they are given certain privileges by those statutes, it has been held by many people that the inference is plain, that on pleasure craft, as well as commercial craft, there should be a life preserver for each person on board. Where such craft have air cushions, or other devices equivalent to life preservers, these might be considered ample protection.

The lights, fog-horn, bell and whistle are all required by act of Congress. In very small motor boats it is impracticable to carry separate side lights, and the supervising inspectors have held that the red, white and green combination lantern, secured on the bow to the jackstaff, or about that position, answered all legal requirements. Of course, separate side lights are better where they can be carried. Every such boat should carry a white lantern as an anchor light. This is a very essential article of equipment, and fully three-quarters of the small yachts fail to comply with this law. It is, of course, not essential that when yachts are all moored together in their regular harbor they each have up these lights, but the law does not provide for exceptions.

As regards a power fog-horn, on all such craft a 25-cent tin horn is all that the law requires. A bell of some sort that can be heard in a fog for a distance sufficient to enable a steamer to clear the anchored craft is required by act of Congress. The practice in regard to the whistle is not uniform. Passenger motor vessels require a mechanical whistle, and on such small craft the small tank where the air is compressed by the motor and released by a lever is advocated. More complicated machines have been fitted up for yachts, but they have usually not proved reliable. On small pleasure motor craft the automobile whistle, or "honk," where the blast is given by squeezing a rubber bulb, would probably comply with the law, while on larger vessels the compressed air tank and lever should be supplied. H.

Notice.

In order that none of our readers may be misled, we wish to call attention to the communication, "Steaming Radius of Scout Cruisers," published on page 454 of our October, 1908, issue, signed "Parsons." This communication was not written by the Hon. C. A. Parsons, or anyone connected with the Parsons Marine Steam Turbine Company, Ltd., the signature being simply a nom-de-plume.

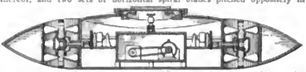
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

896,361. SUBMARINE BOAT. JOHN M. CAGE, DENVER, COL., ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE SUBMARINE NAVIGATION AND MANUFACTURING CO., DENVER.

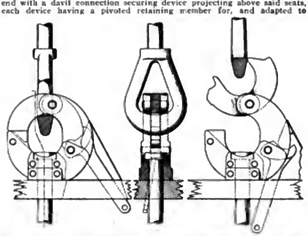
Claim 2.—A submarine boat having a vertical tube adjacent each end thereof, and two sets of horizontal spiral blades pitched oppositely in



respect to each other and arranged within each tube to move in opposite directions about a common vertical axis, and removable covers for each end of each tube. Two claims.

899,072. RELEASING DEVICE FOR BOATS. WILLIAM G. RANDLE, CHESTER, PA.

Claim 3.—In combination, a boat having seats and provided at each end with a davit connection securing device projecting above said seats, each device having a pivoted retaining member for, and adapted to

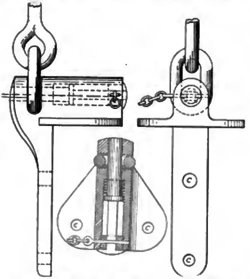


directly engage said connection and a locking dog having a portion projecting below the seats, normally holding said member in the retaining position, but movable to release said member, said member and dog having cam surfaces which directly engage to move the retaining member out of the retaining position, when the dog is moved to release the re-

taining member, and means located beneath the seats and engaging the portions of the locking dogs projecting below the seats for simultaneously moving the locking dogs to release the retaining members controlled by them. Five claims.

898,004. LIFE-BOAT DETACHING DEVICE. JOSEPH PREVOT, GREEN BAY, WIS.

Claim.—A boat-releasing device comprising a metal hanger, bolt plates, a barrel portion, a vertically-disposed slot, a link in said slot, a spring-actuated plunger provided with a cylindrical portion engaging



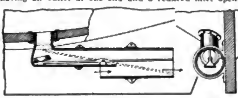
said link, and said plunger also provided with a square portion, a bushing with a square hole threaded into the rear portion of said barrel, and a holding pin for holding the parts in position. One claim.

895,648. ANCHOR OF SUBMARINE BOATS. MAXIME LAUBEUF, PARIS, FRANCE.

Claim.—A submarine or submersible boat having a tube vertically disposed through the hull, having an enlarged lower end for receiving the flukes of an anchor, a chain movable within said tube, a stopper for engaging the chain in the conduit and movable from the interior of the boat, an anchor connected with the chain, and means for preventing the flukes of the anchor touching the hull when the anchor is drawn into the enlarged lower end of the tube. One claim.

899,248. BILGE WATER EJECTOR. LOUIS EBBE, BLAINE, WASH.

Claim 1.—An attachment of the character described, comprising an outlet tube, a tubular body extending beyond one end of said tube and having an outlet at one end and a reduced inlet opening at its other

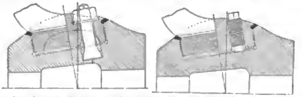


end and below the tube, said tube being disposed to be connected to the bilge of a boat, a valve, and a gravity-operated member for holding the valve normally upon its seat to close the inlet of the tube, said gravity-operated member being disposed within the body, and between the reduced inlet and the outlet thereof. Six claims.

British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

8,880. SCREW PROPELLER. T. EATON, NORWICH, CHESHIRE.

In those propellers, in which the roots of the blades are screwed into the boss and, after adjustment, are fixed in position, means are provided for locking the blades. These means consist of a bolt or stud



passing through the root parallel to its axis, and adapted by its action to press the threads on the root on to the threads in the recess. In one form, the screwed bolt bears on the bottom of the recess; and, in another form, the headed bolt engages in an undercut recess formed in the propeller boss.

8,879. LIFEBOATS. V. COOMBE, BIRKENHEAD.

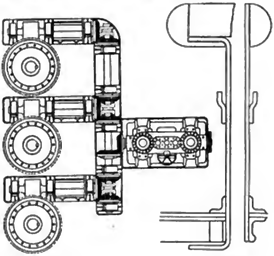
Relates to lifeboats or rafts wherein air chambers or belts of cork are provided on both sides of, and above and below, a platform, which projects beyond the air chambers to form a fender, and consists in providing the air tubes or chambers with battens on both sides to protect the upper and under surfaces. In the reversible lifeboat the platform extends outside the tubular shell, forming a fender. The tubes and platform are fixed together by bolts passing through flanges on the tubes. These tubes are divided into a plurality of compartments by transverse partitions, one or more of these compartments being used for stowing commodities, etc., the others being wholly or partly filled with cork or like material. The boat always floats with the platform above water, and any water that may be shipped discharges through plug holes in the platform.

10,200. MAGNETIC COMPASSES. F. W. CLARK AND KELVIN & JAMES WHITE, GLASGOW.

The journals of the compass bowl and gimbal ring are supported on anti-friction rollers in lubricant filled casings on the gimbal ring and binnacle flange, respectively. Covers keep dust from the casings, which may be supported on springs.

10,295. CAPSTANS. A. KELLY AND C. D. B. HANSEN, GLASGOW.

Three capstans, arranged in a line across the deck of a vessel, are geared to a single winding engine so that they are operated simultaneously; also a fourth hand-operated capstan is positioned so that it can be used to wind any one of the three ropes. Each of the power capstans has a driving connection with a vertical shaft, preferably consisting of a pin disk on the shaft engaging corresponding recesses on the capstan. Each shaft is driven from the engine through a clutch, bevel gearing and worm gearing. Each power capstan is fitted with a suitable friction brake, and one or more of them may be provided with warping drums or whelps for winding steel hawsers.



10,295. 10,801.

10,801. SHIPS' HATCHWAYS. R. I. DUNCAN AND A. ELLIOTT, HARTLEPOOL.

The hatch coaming plates are flanged at the top, and are provided with angle bars, one flange of which forms a molding. The ends of the hatch coamings are not flanged, and the web of the angle bar is cut away when turning the corner, so that the molding flange comes against the coaming.

10,314. SHIPS. C. JEREMIASSEN, PORSGRUND, NORWAY.

Relates to cargo vessels of the type wherein the sides of the hatchways slope from the hatch coamings to the stringer plate, and consists in sloping the ends of the hatchways from the hatch coamings to the deck level. The sloping sides of the hatchways are provided with longitudinal girders, in order to dispense with bold beams and stanchions. Where several hatches are arranged in line the sides are made continuous, and in place of the deck between the hatches a strong transverse connection is fitted. In this construction of vessel the bulwarks may be dispensed with.

10,549. LOADING, ETC. R. BROWN, LIVERPOOL.

A derrick-supported bucket elevator provided with means for breaking and receiving and delivering the material is mounted upon a tender and is employed for loading a vessel from a barge arranged between the tender and the vessel. At the lower end of the elevator frame a shovel or scoop is carried on a crank rotated from the chains. The scoop is provided with a curved guide sliding through a fixed plate, and is so arranged that, as the shovel passes into the material, it assumes a horizontal position and raises a load, which it deposits into the ascending receptacle. The shovel may be flexibly mounted so as to give under a heavy load. In order to give a quicker dipping movement to the shovel, it may be eccentrically mounted on its crank. The scoop carries on its under surface a series of claws designed to bring forward for the next stroke the coal directly behind the scoop.

11,013. STEERING GEAR. A. KELLY AND C. D. B. HANSEN, GLASGOW.

When two steering engines are employed a single controlling gear is adapted to control either engine. The shaft is driven by either or both engines through clutches, and is provided with a worm which engages the worm wheel of the steering shaft. On the main shaft is an additional worm wheel, which engages a worm supported in bearings. A block is rotated by the latter and is moved longitudinally by a hand-operated screwed spindle, and is connected by levers with the shaft which actuates the controlling valves. The spindle is geared to a shaft leading from the steering pedestal, and is provided with a pointer which indicates the position of the steering shaft.

Vol. XIII JANUARY, 1908 No. 1

INTERNATIONAL MARINE ENGINEERING

LONDON
CHRISTOPHER STREET
FINSBURY SQUARE, E. C.

NEW YORK
WHITEHALL BUILDING
17 BATTERY PLACE

International Marine Engineering

JANUARY, 1908

CONTENTS

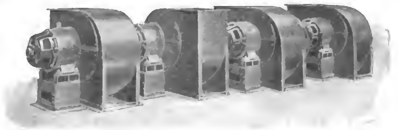
SUBSCRIPTION PRICE
- Great Britain and Ireland, per year, 10/-; per copy, 1/-
- United States, Canada and Mexico, per year, $2.00; per copy, 20 cents
- Other countries in Postal Union, per year, 10/6; per copy, 1/-

LONDON:
CHRISTOPHER STREET
FINSBURY SQUARE, E. C.

NEW YORK:
WHITEHALL BUILDING
17 BATTERY PLACE

"SIROCCO" TRADE MARK

SIROCCO FANS STAY SOLD



PART OF MAURETANIA'S SIROCCO OUTFIT

SIROCCO ENGINEERING COMPANY

FANS AND BLOWERS

138 CEDAR ST., NEW YORK

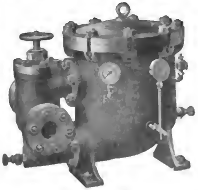
STANDARD ON SEA AND LAND THE WIDE WORLD OVER

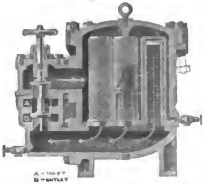
SEE S. S. ADRIATIC, YALE, LA PROVENCE, AMERIKA, &c.

THE BLACKBURN SMITH FEED WATER FILTER

AND

GREASE EXTRACTOR





possesses the following exclusive features:

DOUBLE FILTRATION

All water goes through two separate layers of Terry cloth. Even, after the first layer becomes foul, the second remains practically as clean and effective as ever.

CONVENIENT CARTRIDGES

The cartridges are small and easy to handle, and the spare set can be inserted in a moment without stopping the feed pumps.

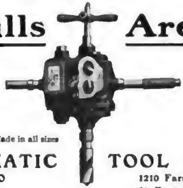
SIMPLE VALVE MECHANISM

The main valves are on one stem and always either by-passed or open by the same amount. Operation is quicker and safer than with the old three hand-wheel system.

WRITE FOR CATALOGUE

JAMES BEGGS & CO., 111 Liberty St., NEW YORK

Thor Air Drills Are Supreme



Corliss Valve Motion

Design and workmanship unexcelled.

Write for Catalog

Made in all sizes

Telescopic Feed

Particularly adapted to Shipyard and Dock work.

Sent on approval

INDEPENDENT PNEUMATIC TOOL COMPANY

First National Bank Building, CHICAGO
170 Broadway, NEW YORK

1210 Farmers Bank Bldg., PITTSBURG, PA.
61 Fremont St., SAN FRANCISCO, CAL.

Our reputation for making Drills and other tools is too well established to be commented upon.

MORSE TWIST DRILL & MACHINE CO.

New Bedford, Mass.

Drills, Reamers, Cutters, Chucks, Taps, Dies, Machines, Machinists' Tools

---

REEVES "TUBAL" MANGANESE BRONZE

FOR PROPELLERS, PISTON RODS, AND ALL CASTINGS REQUIRING HIGH ULTIMATE

A FEW PRACTICAL RESULTS FROM 10 TORPEDO SPOONS (4,200 lbs. each) WE MADE FOR UNITED STATES GOVERNMENT

OFFICIAL TESTS	ULTIMATE	ELASTIC LIMIT	ELONG.	REDUC.
	82 340	33,400	31.5	31.80
	79 320	35,600	28.5	30.12
	79,120	39 040	31.	32.82
	79,840	39,240	27.	30.78
	78,880	38,300	27.	27.8

Sold in Ingots, or Castings up to 20,000 lbs. in weight.

PAUL S. REEVES & SON

PHILADELPHIA, PA., U. S. A.

THE TOLEDO SHIPBUILDING COMPANY

BUILDERS AND REPAIRERS OF

SHIPS AND ENGINES

FRANK E. KIRBY, Consulting Engineer

TOLEDO, OHIO

ALEXANDER McVITTIE, President
CHAS. B. CALDER, General Manager
H. S. WILKINSON, Secretary
L. C. SMITH, Treasurer

"BROWNHOIST"

Steel plate trolley with clevis connection for reduced clearance.

3 to 10 tons.

THE BROWN HOISTING MACHINERY CO.

Main Office and Works, CLEVELAND, O.
NEW YORK PITTSBURG

Engineers and Designers of Hoisting Machinery of every description for the rapid and economical handling of materials.

Write for circulars and catalogues.

FLAT DRILLS

FOR

SHIPYARDS & BOILER SHOPS

"RICH" FLAT DRILL AND CHUCK

FOR HEAVY FEEDS AND HIGH SPEEDS

Will drill the hardest kind of material and retain a sharp cutting edge much longer than the ordinary drill.

The Rich Flat Drill costs less and does more work than any other drill made.

At the New York Navy Yard ten holes were drilled in the armor plate turrets on the Battleship "Connecticut" with a 1¼ inch Rich Flat Drill, while eight twists drills were used without finishing one hole.

CELFOR TOOL COMPANY

BUCHANAN, MICH.

GENERAL SALES OFFICE, RAILWAY EXCHANGE, CHICAGO

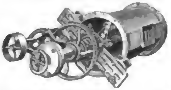
Sectional View "RICH" FLAT DRILL AND CHUCK

COMPOSITE BOARD

Specially adapted for panels, ceilings or wherever large jointless surfaces are desirable. Cut to dimension and furnished ready for decorating—Maximum size of panels 7 feet by 13 feet—Absolutely fire proof. Has been successfully used by every prominent Ship Building Company in the United States.

MANUFACTURED BY **THE COMPOSITE BOARD COMPANY**

General Office, 26 Cortlandt St., New York City — Factory, Niagara Falls, N. Y.



BORING OUT CYLINDERS

used to mean a lot of work. Had to break steam joints, mount the cylinder on a boring mill, and **then** you were only started. Our **PORTABLE BORING MACHINE** has changed all this. Just remove **one** cylinder head and the piston, and a thoroughly accurate job can be **finished** in less time than was formerly needed to get ready. Better look it up.

STOW FLEXIBLE SHAFT CO., Philadelphia, Pa.

IN THE BUSINESS CENTER

It Will Pay You to be Represented

. . . The Exhibition Department of the BOURSE presents an opportunity to Marine Engine and Boat Builders to maintain a permanent exhibit in the business center of the city, where they will come in contact with Buyers from all over the country. Address . . .

THE BOURSE, Phila.

If you want the best in the World, use Stone's Improved Manganese Bronze and Stone's Improved Navy White Bronze, either in Ingots or Castings

[illegible] at, [illegible] knots, or [illegible] 'S IMPROVED MANGANESE BRONZE PROPELLERS, and the bearings are fitted with STONE'S IMPROVED NAVY WHITE BRONZE.

Bronze Propellers save from five to ten per cent. in power, as compared to cast iron or steel.

Stone's Underline Ash and Clinker Expeller

Discharges ashes through bottom of ship by means of compressed air. No noise, no dirt, no injury to paint on hull, no ashes in injection water. Adoped by British Navy, and large passenger lines. Especially suitable for yachts.

Stone's Patent Vertical Motion Windows

fitted in

"LUSITANIA" and "MAURETANIA"

Stone's Side Lights and other Ship Fittings.

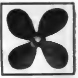
MANUFACTURED BY

THE EXETER MACHINE WORKS

PITTSTON, PA.

NEW YORK OFFICE: 26 Cortlandt Street, New York City

Sole Makers of **HUTSON'S IMPROVED PROPELLERS.**

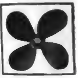


Over 1,200 already fitted.

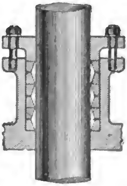
BUILDERS OF PADDLE, STERN WHEEL, AND SCREW MACHINERY.

Engine and Boiler Repairs a Speciality.

SHIPBUILDERS, MARINE ENGINEERS, and BOILER MAKERS.



HUTSON & SONS, Ltd., Kelvinhaugh Engine Works, GLASGOW.



Use "EAGLE" Patent

MECHANICAL PACKING & STEAM TRAPS

SAVES MONEY AND STEAM.

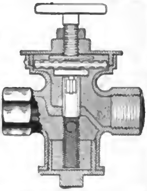
Newest, Best, and Cheapest.

PARTICULARS APPLY . . .

DICK'S ASBESTOS COMPANY,

51 & 52, FENCHURCH ST., LONDON, E.C.

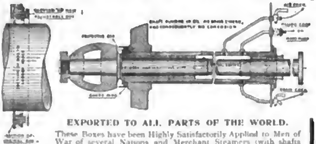
CONTRACTORS TO H.M. GOVERNMENT.



CEDERVALL'S PATENT

PROTECTIVE LUBRICATING BOXES

For Propeller Shafts.



EXPORTED TO ALL PARTS OF THE WORLD.

These Boxes have been Highly Satisfactorily Applied to Men of War of several Nations and Merchant Steamers (with shafts ranging from 3in. to 18¾in. in diameter).

Old Stern Tube Arrangements can be altered for application of this Lubricating Box at a very Nominal Cost.

MANUFACTURERS:

F. R. CEDERVALL & SÖNER,

GOTHENBURG (Sweden).

Also Manufacturers and Exporters of **Special Oil for Stern Tubes.** This Oil is warranted to be about **Three Times** more effective than any other **Oil** for this purpose in the Market.

Price List and Particulars on application.

H. F. BOUGHTON { Registered Patent Agent, G.B. Registered Patent Attorney, U.S.A.

Author of the "Patentee's Guide."

Boughton & Co.

PATENT AGENTS,

276, HIGH HOLBORN,

LONDON, W.C.

Patents and Registrations taken out in all Countries where obtainable, and practical advice given free of charge.

Novelties and Useful Inventions introduced to Sound Financiers.

ARTHUR R. BROWN, A.M.I.C.E.,
54-62, NEW BROAD STREET, LONDON,
Shipbuilder and Engineer.

Telegrams & Cables: "[illegible]," LONDON.
Telephone No. 3415 Wall.

GOLD DREDGERS.
HARBOUR DREDGERS.

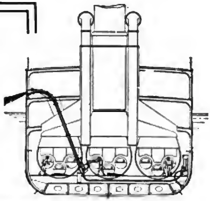
SPECIALITIES.—Amazon Type and Light Draught River Craft of all descriptions, Tugs, Launches, Steam Coasters, Barges, Lighters, Marine Engines and Boilers, &c.

SILVERITE METALLIC PACKING.

Apply to . .
T. W. WRAITH,
38, SIDE,
NEWCASTLE-ON-TYNE.

Suits any sized glands and lasts for years
Keeps the rods like Silver.
Perfect for Winches, Windlasses, Boiler Mountings, Stop and Check Valves, &c., also for Feed Pump Rams and High Pressure Rods.
Used on several hundred Steamers, equally good for Locomotives and Engines.
IN USE FOR TEN YEARS.

16 of these Ejectors have been fitted on the "Mauretania" and "Lusitania,"



SEE'S ASH EJECTOR.

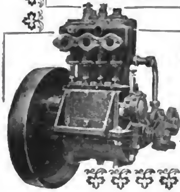
WITH ALL RECENT IMPROVEMENTS.

Sole Licensee:—
F. J. TREWENT,
(F. J. TREWENT & W. E. PROCTOR,)
NAVAL ARCHITECTS & CONSULTING ENGINEERS,
43, BILLITER BUILDINGS, BILLITER ST.,
Telephone No. 121 Avenue.
Telegrams: "TREWENT, LONDON." LONDON, E.C.

STEEL BOATS

Designed for Home or Export.
FOR PLEASURE, RACING, OR COMMERCIAL USE.
Catalogues free on application.

BOULTON & PAUL, Ltd.
Engineers,
NORWICH, ENGLAND.
Cables: "Boulton, Norwich, England."



MARINE ENGINES,
Two and Four Cycle.
PETROL OR PARAFFIN.
Catalogue on application.

THE "NO TROUBLE" MOTOR.

The Ailsa Craig Motor has been called the "No Trouble" Motor by those who have worked it.

One reason why it gives no trouble is because of its simple design. It has fewer parts than any other four-stroke motor on the market.

Another reason why the Ailsa Craig gives no trouble is because of the superb workmanship that goes into it.

And, finally, each Ailsa Craig Motor is subjected to long and severe trials at the testing beds before it is allowed to pass into Stores for delivery.

Our New Booklet No. 9 fully explains the "No Trouble" Motor. Post free on request.

THE AILSA CRAIG MOTOR Co.

Strand-on-the-Green,
CHISWICK, LONDON, W.

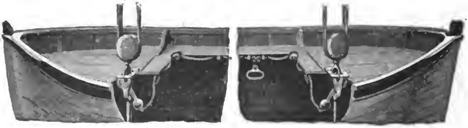
Mills' Engaging and Disengaging Gear

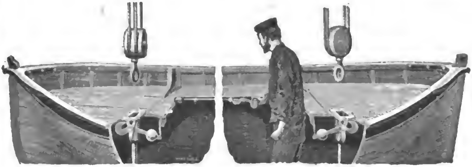
For Boats, Launches, etc.

APPROVED BY THE U. S. BOARD OF SUPERVISING INSPECTORS AND THE ENGLISH BOARD OF TRADE AND OTHER GOVERNMENTS

THE SIMPLE METHOD OF ENGAGING

ABSOLUTE SAFETY WHEN ENGAGED





THE SIMPLE METHOD OF DISENGAGING

HAS OBTAINED THE HIGHEST AWARDS WHEREVER EXHIBITED

Is now in use by over 300 Steamship Lines trading to all parts of the world, besides a number of Pilotage Boards, Cable Ships and many Yacht Owners. When building new lifeboats this gear can be installed as easily as any other.

Full particulars from

WELIN QUADRANT DAVIT CO.

A. P. LUNDIN, Manager

17 BATTERY PLACE NEW YORK, N. Y.

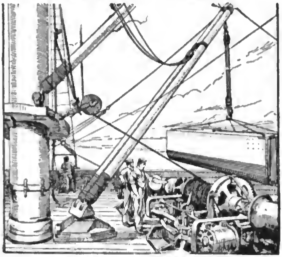
CLASSIFIED INDEX TO ADVERTISERS

(Index continued on page 92.)

PORTER'S

PATENT DERRICK FITTINGS.

Weights up to 25 tons can be lifted by the vessel's working derricks, combining on a single pivot or goose-neck. Saves the cost of large *spare spar*, and earns for the shipowner the cost of *extra cranage*.



For particulars apply to

EAST FERRY ROAD ENGINEERING WORKS Co. Ld.

'EAST FERRY ROAD, MILLWALL, LONDON, E.'

WE SELL ALL BOOKS

ON

MARINE ENGINEERING

NOT OUT OF PRINT

INTERNATIONAL MARINE ENGINEERING

LONDON:	NEW YORK:
CHRISTOPHER STREET	WHITEHALL BUILDING
FINSBURY SQUARE, E. C.	17 BATTERY PLACE

THE PROFESSOR ON SHIPBOARD

A STORY

NOTHING has ever been published which contains so much everyday information which every engineer ought to know as this book. In addition to the practical information it contains, it is a most readable story of life at sea. There are twelve chapters, as follows: I, In the Fireroom; II, Hardships of Firemen; III, Night Watch in a Gale; IV, Interview with Barney, the Oiler; V, Some Points on Lubrication; VI, Why Engines are Non-efficient; VII, Salt Water and Boiler Scale; VIII, Cleaning Boilers in a Tropical Port; IX, How to Use Indicators; X, Simple Explanation of the Indicator; XI, Overhauling the Machinery; XII, Painting the Pipe System. 100 pages. By C. A. McAllister. Price, $1.00, Postpaid.

For sale by

INTERNATIONAL MARINE ENGINEERING

17 Battery Place, - - - - - - New York City

Christopher St., Finsbury Sq., London, E. C.

BENCH TOOLS.
Billings & Spencer Co., Hartford, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Pratt & Whitney Co., New York.
Starrett, L. S., Co., Athol, Mass.
Trimont Mfg. Co., Roxbury, Mass.
Williams & Co., J. H., Brooklyn, N. Y.
Winn, C., & Co., Birmingham.

BENDING MACHINES, KEEL PLATE OR GARBOARD.
Niles-Bement-Pond Co., New York.

BENDING ROLLS—See ROLLS.

BILGE PUMPS—See PUMPS.

BILGE SYPHONS.
Braender, Philip, New York.

BINNACLES.
Heath & Co., Ltd., London.
Terry Co., G. H., New York.

BINOCULARS—See MARINE GLASSES.

BLOCKS.
Boston & Lockport Block Co., Boston, Mass.
Loveridge, Ltd., Cardiff.

BLOWERS.
American Blower Co., Detroit, Mich.
Beggs, James, & Co., New York.
De Laval Steam Turbine Co., Trenton, N. J.
General Electric Co., Schenectady, N. Y.
Howden, J., & Co., Glasgow.
Sturtevant Co., B. F., Hyde Park, Mass.

BLOW-OFF VALVES—See VALVES.

BLUE-PRINTING SUPPLIES—See DRAFTMEN'S SUPPLIES.

BOAT BUILDERS—See LAUNCHES AND YACHTS.

BOAT FITTINGS.
Ferdinand, L. W., & Co., Boston, Mass.
Terry Co., G. H., New York.

BOILER CIRCULATORS.
Bloomsburg, H., & Co., Baltimore, Md.

BOILER FEEDERS—See FEED-WATER REGULATORS.

BOILERS—Also see ENGINE BUILDERS; also SHIP BUILDERS.
Abern, D., New York.
Almy Water Tube Boiler Co., Providence, R. I.
Atlantic Works, The, East Boston, Mass.
Babcock & Wilcox Co., New York.
Bath Iron Works, Bath, Me.
Beggs, James, & Co., New York.
Brown, Arthur R., London.
Great Lakes Engineering Works, Detroit, Mich.
Howden, J., & Co., Glasgow.
Hutson & Sons, Ltd., Glasgow.
Kingsford Foundry & Machine Works, Oswego, N. Y.
Mosher Water Tube Boiler Co., New York.
Philip & Son, Ltd., Dartmouth.
Quiotard Iron Works Co., New York.
Richardsons, Westgarth & Co., Hartlepool.
Roberts Safety Water Tube Boiler Co., New York.
Rowan, David, & Co., Glasgow.
Sisson & Co., W., Ltd., Gloucester.
Taylor Water Tube Boiler Co., Detroit, Mich.
White, J. Samuel, & Co., Ltd., East Cowes, Isle of Wight.

BOILER COMPOUNDS.
Bird-Archer Co., The, New York.

BOILER COVERING—See NON-CONDUCTING COVERING.

BOILER FEED PUMPS—See PUMPS.

BOILER-FLUE AND TUBE CLEANERS.
Griscom-Spencer Co., New York.

BOILER AND PIPE COVERINGS—See NON-CONDUCTING COVERING.

BOILER STAYBOLTS—See STAYBOLTS.

BOILER ROOM FITTINGS.
American Blower Co., Detroit, Mich.
Ashcroft Mfg. Co., New York.
Ashton Valve Co., Boston, Mass.
Crane Co., Chicago, Ill.
Griscom-Spencer Co., New York.
Hancock Inspirator Co., New York.
Hayden & Derby Mfg. Co., New York.
Howden, J., & Co., Glasgow.
Jackson, John, London.
Jerguson Mfg. Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Mason Regulator Co., Boston, Mass.
Powell, Wm., Co., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.
Walworth Mfg. Co., Boston, Mass.
Winn, C., & Co., Birmingham.

BOILER TUBES.
Beggs, James, & Co., New York.
Shelby Steel Tube Co., Pittsburg, Pa.
Walworth Mfg. Co., Boston, Mass.

BOILER TUBE CUTTERS.
Stow Flexible Shaft Co., Philadelphia, Pa.

BOILER TUBE RETARDERS.
Griscom-Spencer Co., New York.

BOLTS AND NUTS.
Bayliss, Jones & Bayliss, Wolverhampton.
Russell, Burdsall & Ward Bolt and Nut Co., Port Chester, N. Y.

BOOKS.
Griffin, Chas., & Co., London.
Sotheran, J. W., London.
Spon, E. & F. N., London.

(Index continued on page 98.)

BORING BARS—See CYLINDER BORING BARS.

BORING MACHINES—METAL WORKING.
Niles-Bement-Pond Co., New York.

BORING MACHINES—WOOD.
Independent Pneumatic Tool Co., Chicago and New York.

BORING AND TURNING MILLS.
Niles-Bement-Pond Co., New York.

BRANDING IRONS.
Pryor, E., & Son, Sheffield.

BRASS AND COPPER—Also see YELLOW METAL; also MUNTZ METAL.
Ajax Metal Co., Philadelphia, Pa.
Exeter Machine Works, Pittston, Pa.
Hussey, C. G., & Co., Pittsburg, Pa.
Lunkenheimer Co., Cincinnati, Ohio.
Phosphor Bronze Co., Ltd., London.
Reeves, Paul S., & Son, Philadelphia, Pa.
Taunton-New Bedford Copper Co., New Bedford, Mass.
Toledo Shipbuilding Co., Toledo, Ohio.

BRAZING MATERIALS.
Smooth-On Mfg. Co., Jersey City, N. J.

BRONZE.
Ajax Metal Co., Philadelphia, Pa.
Exeter Machine Works, Pittston, Pa.
Lunkenheimer Co., Cincinnati, Ohio.
Phosphor Bronze Co., Ltd., London.
Phosphor-Bronze Smelting Co., Philadelphia, Pa.
Reeves, Paul S., & Son, Philadelphia, Pa.
Taunton-New Bedford Copper Co., New Bedford, Mass.

BRONZE CASTINGS—See CASTINGS—BRONZE.

BUOYS.
Sands, A. B., & Son Co., New York.
Terry, G. H., Co., New York.

BUSHINGS, METALINE AND PHOSPHOR-BRONZE.
Boston & Lockport Block Co., Boston, Mass.
Phosphor Bronze Co., Ltd., London.
Reeves, Paul S., & Son, Philadelphia, Pa.

BUTTERFLY VALVES—See VALVES.

BY-PASS VALVES—See VALVES.

CABIN FITTINGS.
Terry, G. H., Co., New York.

CABLEWAYS—See MARINE CABLEWAYS.

CAISSONS.
Ferguson Bros., Port Glasgow.

CALKING TOOLS—Also see CHANDLERY STORES.
Boston & Lockport Block Co., Boston, Mass.

CAPSTANS—See WINDLASSES.

CARBURETTORS.
Turner Brass Works, Sycamore, Ill.

CARGO BLOCKS—See BLOCKS.

CASTINGS—BRONZE—Also see STEEL CASTINGS.
Hyde Windlass Co., Bath, Me.
Lunkenheimer Co., Cincinnati, Ohio.
Phosphor Bronze Co., Ltd., London.
Phosphor-Bronze Smelting Co., Philadelphia, Pa.
Reeves, Paul S., & Son, Philadelphia, Pa.

CELLAR DRAINERS.
Braender, Philip, New York.

CENTRIFUGAL PUMPS—See PUMPS.

CHAIN PIPE WRENCHES—See WRENCHES.

CHANDLERY STORES.
Ferdinand, L. W., & Co., Boston, Mass.
Griscom-Spencer Co., New York.
Terry, G. H., Co., New York.

CHART HOLDERS.
Wilson & Gillie, North Shields.

CHECK VALVES—See VALVES.

CHRONOMETERS—See CHANDLERY STORES.

CHUCKS.
Celfor Tool Co., Buchanan, Mich.
Morse Twist Drill & Machine Co., New Bedford, Mass.

CIRCULATING PUMPS—See PUMPS.

CIRCULATORS.
Bloomsburg, H., & Co., Baltimore, Md.

CLASSIFICATION ASSOCIATION.
American Bureau of Shipping, New York.

CLOCKS.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Star Brass Mfg. Co., Boston, Mass.

COCKS—See GAUGE COCKS.

COAL HANDLING MACHINERY.
Lidgerwood Mfg. Co., New York.

COLLECTORS—PNEUMATIC.
Sturtevant Co., B. F., Hyde Park, Mass.

COMPANION FLANGES.
Crane Co., Chicago, Ill.
Lunkenheimer Co., Cincinnati, Ohio.

COMPASSES—See NAUTICAL INSTRUMENTS.

COMPOUNDS—See BOILER COMPOUNDS AND PIPE-JOINT COMPOUNDS.

CONDENSERS.
Davidson, M. T., Co., New York.
Great Lakes Engineering Works, Detroit, Mich.
Richardsons, Westgarth & Co., Hartlepool.
Wheeler, C. H., Mfg. Co., Philadelphia, Pa.
Wheeler Condenser and Engineering Co., New York.
Williamson Bros. Co., Philadelphia, Pa.

(Index continued on page 94.)

(Index continued on page 96.)

DRY DOCKS AND MARINE RAILWAYS.
Atlantic Works, East Boston, Mass.
Great Lakes Engineering Works, Detroit, Mich.
Halifax Graving Dock Co., Ltd., Halifax, N. S.
Merrill-Stevens Engineering Co., Jacksonville, Fla.
Moran Co., The, Seattle, Wash.
Newport News Shipbuilding & Dry Dock Co., Newport News, Va.
Tietjen & Lang Dry Dock Co., Hoboken, N. J.
Toledo Shipbuilding Co., Toledo, Ohio.

DRYING APPARATUS.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

DYNAMOS—See ELECTRICAL PLANTS; also STEAM TURBINE DYNAMOS; also IGNITION DYNAMOS.

ECONOMIZERS, FUEL—See FUEL ECONOMIZERS.

EJECTORS.
Beggs, James, & Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.

ELECTRIC BELLS.
Holtzer-Cabot Electric Co., Brookline, Mass.

ELECTRIC DRILLS.
General Electric Co., Schenectady, N. Y.
Hisey-Wolf Machine Co., Cincinnati, Ohio.
Holtzer-Cabot Electric Co., Brookline, Mass.
Independent Pneumatic Tool Co., Chicago and New York.
Stow Flexible Shaft Co., Philadelphia, Pa.

ELECTRIC HEATERS.
General Electric Co., Schenectady, N. Y.
Holtzer-Cabot Electric Co., Brookline, Mass.
Simplex Electric Heating Co., Cambridgeport, Mass.

ELECTRIC HOISTS.
General Electric Co., Schenectady, N. Y.
Holtzer-Cabot Electric Co., Brookline, Mass.
Hyde Windlass Co., Bath, Me.
Lidgerwood Mfg. Co., New York.
Niles-Bement-Pond Co., New York.
Williamson Bros. Co., Philadelphia, Pa.

ELECTRIC LAUNCHES.
Electric Launch Co., Bayonne, N. J.

ELECTRIC MOTORS FOR OPERATING TURRETS, ETC.
Holtzer-Cabot Electric Co., Brookline, Mass.

ELECTRIC PLANTS.
Ailsa Craig Motor Co., Chiswick.
Boulton & Paul, Norwich.
Buffalo Mechanical & Electrical Laboratory, Buffalo, N. Y.
Forbes, W. D., Co., Hoboken, N. J.
General Electric Co., Schenectady, N. Y.
Griffin Engineering Co., Bath.
Martin, W. C., & Co., Glasgow.
Mietz, A., New York.
Richardsons, Westgarth & Co., Hartlepool.
Sturtevant Co., B. F., Hyde Park, Mass.

ELECTRICAL FITTINGS AND SUPPLIES—Also see ELECTRIC PLANTS.
General Electric Co., Schenectady, N. Y.
Holtzer-Cabot Electric Co., Brookline, Mass.
Martin, W. C., & Co., Glasgow.

ELECTRICAL INSTRUMENTS.
General Electric Co., Schenectady, N. Y.
Holtzer-Cabot Electric Co., Brookline, Mass.
Weston Electrical Instrument Co., Waverly Park, Newark, N. J.

ENGINE-ROOM SUPPLIES—See STEAM SPECIALTIES.

ENGINEERS, CONSULTING.
Beldam, Robert, London.
Brown, Arthur R., London.
Buffalo Mechanical & Electrical Laboratory, Buffalo, N. Y.
Joy, David & Cooper, Southampton.
King, J., Co., London.
Smith & Robinson, Philadelphia, Pa.
Trewent, F. J., London.
Williamson Bros. Co., Philadelphia, Pa.

ENGINES FOR AUXILIARIES.
American Blower Co., Detroit, Mich.
Beggs, James & Co., New York.
Buffalo Mechanical & Electrical Laboratory, Buffalo, N. Y.
Chase Machine Co., Cleveland, Ohio.
Dake Engine Co., Grand Haven, Mich.
De Laval Steam Turbine Co., Trenton, N. J.
Forbes, W. D., Co., Hoboken, N. J.
Hutson & Sons, Ltd., Glasgow.
Hyde Windlass Co., Bath, Me.
New Britain Machine Co., New Britain, Conn.
Philip & Son, Ltd., Dartmouth.
Richardsons, Westgarth & Co., Hartlepool.
Sturtevant Co., B. F., Hyde Park, Mass.
Wheeler Condenser and Engineering Co., New York.

ENGINES, GASOLINE—See GASOLINE ENGINES.

ENGINES, HOISTING—See HOISTING ENGINES.

ENGINES, KEROSENE—See KEROSENE ENGINES.

ENGINES, PROPELLING—Also see SHIPBUILDERS.
Atlantic Works, The, East Boston, Mass.
Bath Iron Works, Bath, Me.
Beggs, James, & Co., New York.
Boulton & Paul, Norwich.
Brown, Arthur R., London.
Forbes Co., W. D., Hoboken, N. J.
Great Lakes Engineering Works, Detroit, Mich.
Griffin Engineering Co., Bath.
Hutson & Sons, Ltd., Glasgow.
Kingsford Foundry & Machine Works, Oswego, N. Y.
Howden, J., & Co., Glasgow.
Morris Machine Works, Baldwinsville, N. Y.
Philip & Son, Ltd., Dartmouth.
Quintard Iron Works Co., New York.
Richardsons, Westgarth & Co., Hartlepool.
Rowan, David, & Co., Glasgow.

(Index continued on page 96.)

(Index continued on page 97.)

(Index continued on page 98.)

HOSE NOZZLES.
Hayward, S. F., Co., New York.
Morse, Andrew J., & Son, Inc., Boston, Mass.
HYDRAULIC JACKS.
Watson-Stillman Co., New York.
HYDRAULIC MACHINERY—RIVETERS, PUNCHES, SHEARS.
Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.
HYDRAULIC RAMS.
Boulton & Paul, Norwich.
HYDROMETERS.
Wilson & Gillie, North Shields.
ICE MACHINES—See REFRIGERATING PLANTS.
IGNITION DYNAMOS.
Holtzer-Cabot Electric Co., Brookline, Mass.
Terry, G. H., Co., New York.
INDIA OIL STONES.
Norton Co., Worcester, Mass.
INDICATOR CONNECTIONS.
Lunkenheimer Co., Cincinnati, Ohio.
INDICATORS—GAS ENGINE.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
INDICATORS—STEAM.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashcroft Mfg. Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., The Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.
INDUCED DRAFT.
American Blower Co., Detroit, Mich.
Brown, John, & Co., Ltd., New York.
Sirocco Engineering Works, New York.
Sturtevant Co., B. F., Hyde Park, Mass.
INJECTORS.
Beggs, James, & Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Detroit, Mich.
Powell Co., The Wm., Cincinnati, Ohio.
INTERLOCKING RUBBER TILING.
Goodyear Tire & Rubber Co., Akron, Ohio.
IRON CEMENT.
Smooth-On Mfg. Co., Jersey City, N. J.
JACKS FOR UNCOUPLING SHAFTS.
Watson-Stillman Co., New York.
JUTE.
Columbian Rope Co., Auburn, N. Y.
KEROSENE ENGINES.
Mietz, A., New York.
Termaat & Monahan Co., Oshkosh, Wis.
LAMPS, SIGNALS, AND FIXTURES.
General Electric Co., Schenectady, N. Y.
Terry, G. H., Co., New York.
Worton & Bradberry, Birmingham.
LATHES, CRANK SHAFT.
Niles-Bement-Pond Co., New York.
LATHES, ENGINE
Brown & Sharpe Mfg. Co., Providence, R. I.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., New York.
LATHES, TURRET.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., New York.
LAUNCHES AND YACHTS.
Ailsa Craig Motor Co., Chiswick.
Atlantic Co., The, Amesburg, Mass.
Boulton & Paul, Norwich.
Bridgeport Motor Co., Bridgeport, Conn.
Brown, Arthur R., London.
Buffalo Gasolene Motor Co., Buffalo, N. Y.
Electric Launch Co., Bayonne, N. J.
King, J., Co., London.
Philip & Son, Ltd., Dartmouth.
Sisson & Co., W., Ltd., Gloucester.
Standard Motor Construction Co., Jersey City, N. J.
Terry, G. H., Co., New York.
White, J. Samuel, & Co., Ltd., East Cowes.
LAVATORIES—See PLUMBING.
LIFE BOATS.
Lane & De Groot, Long Island City, N. Y.
LIFE PRESERVERS.
Armstrong Cork Co., Pittsburg, Pa.
Ferdinand, L. W. & Co., Boston, Mass.
Lane & De Groot, Long Island City, N. Y.
Nonpareil Cork Works, New York.
LIFE RAFTS.
Lane & De Groot, Long Island City, N. Y.
LIFE SAVING DEVICES—Also see SUBMARINE SIGNALS.
Lane & De Groot, Long Island City, N. Y.
Lundin, A. P., New York.
Submarine Signal Co., Boston, Mass.
Welin, Axel, London.
LOCKS, SHIPS'.
Lowe & Fletcher, Willenhall.
LOCK NUTS.
Bayliss, Jones & Bayliss, Wolverhampton.
LUBRICANTS.
Cook's Sons, Adam, New York.
Dixon, Jos., Crucible Co., Jersey City, N. J.
Garlock Packing Co., Palmyra, N. Y.
New York & New Jersey Lubricant Co., New York.
Power Specialty Co., New York.
Terry, G. H., Co., New York.
LUBRICATING BOXES FOR PROPELLER SHAFTS.
Cedervall, F. R., & Söner, Gothenburg, Sweden.

(Index continued on page 99.)

(Index continued on page 100.)

NOZZLES—See HOSE NOZZLES.

NUTS—See BOLTS AND NUTS; also LOCK NUTS.

OIL—See LUBRICANTS.

OIL CUPS—See LUBRICATORS.

OIL GAUGES.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., The Wm., Cincinnati, Ohio.

OIL POLISH—See METAL POLISH.

OIL PUMPS.
Lunkenheimer Co., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

OILING SYSTEMS.
Powell Co., Wm., Cincinnati, Ohio.
Spence & Son, R., Richmond.

PACKING—Also see METALLIC PACKING.
Angus, Geo., & Co., Ltd., Newcastle-on-Tyne.
Beldam Packing & Rubber Co., London.
Beldam, Robert, London.
Boston Belting Co., Boston, Mass.
Crandall Packing Co., Palmyra, N. Y.
Crane Co., Chicago, Ill.
Dick's Asbestos Co., London.
France Packing Co., Tacony, Philadelphia, Pa.
Garlock Packing Co., Palmyra, N. Y.
Greene Tweed & Co., New York.
Peerless Rubber Mfg. Co., New York.
Power Specialty Co., New York.
Revere Rubber Co., Boston, Mass.

PACKING, ASBESTOS.
Angus, Geo., & Co., Ltd., Newcastle-on-Tyne.
Crandall Packing Co., Palmyra, N. Y.
Dick's Asbestos Co., London.
Duff & Co., Glasgow.

PADLOCKS.
Lowe & Fletcher, Willenhall.

PAINT—Also see GRAPHITE.
Coleman, Geo. D., Boston, Mass.
Dixon, Jos., Crucible Co., Jersey City, N. J.
Standard Varnish Works, New York.

PATENT ATTORNEYS—See ATTORNEYS, PATENT.

PENNANTS—See FLAGS and COLORS.

PHOSPHOR BRONZE CASTINGS.
Hyde Windlass Co., Bath, Me.
Lunkenheimer Co., Cincinnati, Ohio.
Phosphor Bronze Co., Ltd., London.
Phosphor-Bronze Smelting Co., Philadelphia, Pa.
Reeves, Paul S., & Son, Philadelphia, Pa.

PIEZOMETERS, NOZZLE.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

PIPE COVERING—See NON-CONDUCTING COVERING.

PIPE CUTTING AND THREADING MACHINES.
Crane Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Saunders' Sons, D., Yonkers, N. Y.
Trimont Mfg. Co., Roxbury, Mass.

PIPE FLANGES—See FLANGES.

PIPE JOINT COMPOUNDS.
Edgecombe Co., The, Cuyahoga Falls, Ohio.

PIPE UNIONS.
Crane Co., Chicago, Ill.
Dart, E. M., Mfg. Co., Providence, R. I.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., The Wm., Cincinnati, Ohio.

PIPE WRENCHES.
Billings & Spencer Co., Hartford, Conn.
Crane Co., Chicago, Ill.
Trimont Mfg. Co., Roxbury, Mass.
Williams & Co., J. H., Brooklyn, N. Y.

PLANERS, STANDARD METAL WORKING AND ROTARY.
Niles-Bement-Pond Co., New York.

PLANERS, SHIP PLATE.
Niles-Bement-Pond Co., New York.

PLANIMETERS.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Star Brass Mfg. Co., Boston, Mass.

PLATE-BENDING ROLLS.
Niles-Bement-Pond Co., New York.

PLUMBAGO—Also see GRAPHITE.
Dixon, Jos., Crucible Co., Jersey City, N. J.

PLUMBING—Also see CHANDLERY STORES.
Crane Co., Chicago, Ill.
Davidson, M. T., Co., New York.
Sands, Alfred B. & Son Co., New York.
Terry, G. H., Co., New York.

PNEUMATIC SEPARATORS.
Beggs, James, & Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

(Index continued on page 101.)

(Index continued on page 102.)

(Index continued on page 108.)

(Index continued on page 104.)

(Index continued on page 105.)

(Index continued on page 106.)

INDEX TO ADVERTISERS

(Index continued on page 107.)

(Index continued on page 108.)

PAGES.

TRADE PUBLICATIONS.

AMERICA

"**Hand-Book of the Philadelphia Bourse**" is a 24-page booklet of interest to manufacturers of marine and land machinery, tools, equipment and supplies. It describes in detail the exhibition features of the Bourse, Philadelphia, Pa., which is a permanent exposition of the lines referred to, giving the exhibitor more than ordinary office facilities and the opportunity to show his machines in motion if he likes, where many thousands of visiting buyers are attracted. The booklet is illustrated with half-tones showing exhibits of representative concerns and is accompanied by a diagram showing floor plan.

Pipe machines are described and illustrated in a 24-page pamphlet published by Crane Company, Chicago, Ill. The machines described in this catalogue have a capacity of from ⅛ to 18 inches. The following description is given of the No. 1½ machine with a capacity of ⅛ to 2 inches: "This machine is designed for great rapidity of production. The die head is movable, and carries with it adjustable expanding dies, movable centering guide jaws for cutting off pipe, and movable reaming and gaging device. The dies, four to a set, are actuated by an internal cam, operated by a lever. Moving this lever either forward or backward adjusts or expands the dies. To remove dies, the die head has a hinged door which can be opened and all dies exposed. When cutting or threading pipe below 1 inch, an extension die head is supplied, which supports the dies to prevent their bending, and should always be used. For cutting left-hand threads a suitable cage is supplied which fits into the die head. The gripping chuck is of the quick-grip type and consists of four jaws, each having two surface contacts, made of high-grade tool steel, and by turning a screw can be quickly adjusted to grip any size pipe within the capacity of the machine. When jaws are set they will grip or release pipe by the moving of a lever either to the right or to the left, without stopping the machine. At the rear end of the spindle there is a universal centering chuck to guide long lengths of pipe when threading. A rotary oil pump for supplying oil is furnished. When belt driven, change of speed and reverse motion can be obtained by countershaft. A complete set of pipe-gage blanks for adjusting dies is furnished. Solid bolt, or left-hand dies are furnished if desired at additional cost."

"**Motors and Accessories**" is the title of an illustrated catalogue published by the F. A. Brownell Motor Company, Rochester, N. Y., successor to the Brownell-Trebert Company. This company makes a specialty of large marine motors adapted for heavy cruisers, racing boats and pleasure yachts.

"**Perfect Control**" is the title of an illustrated booklet published by C. F. Roper & Company, Hopedale, Mass. "Motor boat users have wished in vain for a boat which should be driven by the simple and convenient gasoline engine, but which should still possess that perfect control over speed and direction hitherto found only in connection with a steam plant or an electric motor. The Roper speed controlling, reversing propeller has been designed with a view to realize this ideal and does realize it. A gasoline launch equipped with this propeller can be driven at any speed desired, ahead or astern, from absolute rest up to the maximum, with no adjustment of the motor or liability of its stopping. The propeller is designed so as to keep the resistance on the engine substantially uniform whatever the speed of the boat may be, and accordingly all racing of the engine with its consequent skipping of impulses, sudden stops and nerve shaking explosions in the muffler, is eliminated. The danger and nuisance of these troubles are well known and require little comment. Suffice it to say that with our propeller there need be no apprehension concerning one's ability to control the speed of his boat when making a landing or going over places where the bottom is feared or known to be rocky. The speed may also be easily adjusted for fishing, trolling or the like. This control is obtained by the movement of a single lever, which moves the propeller blades through the various positions shown in the illustrations as well as all intermediate positions. There is absolutely no necessity for changing the adjustment of the engine after it is properly set for full speed ahead. The strength of the propeller is ample, and its simplicity may be perceived by a glance at the cut of its constituent parts. Any machinist can install it. It is balanced so perfectly that there is no jerkiness felt in moving the blades to reversing position, or vice versa. Another advantage found in the use of this propeller, which was unsought by the designer, is increased speed. Wherever applied thus far this result has been noted, and in some cases has amounted to a gain of at least a mile an hour in speed without any increase in the speed of the engine."

"Core Box Machines," "Saw Dado or Grooving Heads," "Universal Trimmers," "Post Boring Machines" and "Mitering Machines" are described and illustrated in catalogues distributed by the Fox Machine Company, Grand Rapids, Mich., free copies of which will be sent upon application to any of our readers.

The Protection of Machinery from Rust and Corrosion.—A slushing compound made by Warren Brothers' Company, 93 Federal street, Boston, Mass., is stated to be the best method for the protection of machinery from rust and corrosion, and the manufacturers state that when protected by their compound, machinery may be immersed in salt water without bad effect. It is stated that this compound dries in from 15 to 20 minutes, and then may be handled without danger of exposing parts slushed. This compound is applied with a brush, and is said to cover about 1,200 square feet per gallon. It may be easily and quickly removed with waste and kerosene. The manufacturer states that Warren's slushing compound is not a paint, grease or lacquer, but a scientifically prepared chemical composition, which will withstand rain, sunshine, heat and frost.

Advantages of Amorphous Graphite as a Lubricant, by H. C. Woodruff. "Although the excellence of graphite for all sorts of lubrication and its particular adaptability to certain difficult lubrication is a matter with which most of us are familiar, few, perhaps, are cognizant of the fact that there are two forms of graphite—flake, or foliated, and amorphous, or non-structural, graphite—and that though chemically the same the latter is capable of finer pulverization, and with careful treatment may be reduced to an impalpably fine powder, absolutely free from grit or any sort of harmful impurity. Flake graphite, on the other hand, no matter how finely pulverized, always retains its original mica-like or crystalline structure and, comparing one with the other, there is a vast difference in nature, texture, action and effect. In the first place, amorphous graphite is adhesive in the highest degree. It stays put, and adhesiveness is one of the first requisites of an efficient lubricant, in that to cool a hot bearing it is absolutely essential that the lubricating agent 'stay put' where applied. To illustrate: Take a pinch of finely pulverized amorphous graphite and rub same in the palm of the hand, on paper or on some other convenient surface and observe its action. Note that the more one rubs the more effective the lubrication, for this form of graphite is not easily removed from surfaces in frictional contact, but maintains constant and effective duty right at the point of contact, and is at its best under heavy frictional pressure, in that as above stated it is adhesive in the highest degree—'stays put' —and there is absolutely no waste, as every particle is an active lubricating factor. Then, too, as an impalpable powder it readily and quickly penetrates and distributes itself in a smooth, slippery, even coating between the tightest bearings, filling every pore, crevice and interstice, thereby evening irregular bearing surfaces and reducing friction to a minimum. Let us also see how, mixed with lubricating oils, this amorphous graphite will minimize friction. A microscopic examination of perfectly smooth bearings—cylinder surfaces for instance—will disclose many minute irregularities which, in the nature of things, must be productive of more or less friction. This friction, of course, means wasted energy—energy that instead of being utilized as power is absorbed as heat—a condition that more often than not means an overheated bearing with the consequent loss of time and temper. To effectively overcome this friction and utilize this otherwise wasted power, a lubricant possessing considerable 'body' is required—that is, a substantial lubricant of such a nature as to eliminate as far as possible these microscopical irregularities and provide a bearing offering minimum resistance to the surfaces in play. Experience, which is man's teacher, has not only demonstrated time and again that oil in itself will accomplish this only to a certain extent, but it has also taught that pure soft, finely powdered graphite, properly and judiciously applied, will do wonders, so it only remains to make the proper application of the right sort of graphite. It has, therefore, long been the endeavor of intelligent engineers to secure a graphited oil, that is to say, an oil in which graphite floats or is held in suspension without precipitation, sufficiently long to perform its duty, for it is easy to see the great advantage to be derived from the use of an oil having every drop impregnated with solid lubricating matter. This seemingly simple problem, however, is one that has until lately baffled engineers of experience, but it has now been found that amorphous graphite when reduced to an impalpably fine powder will, when mixed with oil in the proportion of about one teaspoonful to the pint of oil, remain in perfect suspension long enough to feed through lubricator tubes without clogging, thus causing every drop of oil to carry its mite of graphite. The United States Graphite Company, Saginaw, Mich., prepares a lubricating graphite of this description."

Plastic bronze is the subject of a pamphlet distributed by the Ajax Metal Company, Philadelphia, Pa. This pamphlet states that the company was led to experiment in the endeavor to produce an alloy with lower tin and higher lead content, and that by means of a process invented and patented in 1900 it has been enabled to alloy copper and lead in any proportions with or without tin. The company has adopted a formula containing 30 per cent lead and 5 per cent tin for general purposes. This the company terms "Ajax Plastic Bronze."

The serial on pressure reducing valves, by W. H. Wakeman, is still running in *Graphite*, published monthly by the Joseph Dixon Crucible Company, Jersey City, N. J. Those of our readers mentioning this magazine will be put upon the free mailing list of *Graphite*, which will be found interesting to all engineers and others interested in the subject of lubrication.

"Speed Wheels" are the subject of a 32-page catalogue handsomely illustrated in several colors, issued by the Michigan Wheel Company, Grand Rapids, Mich. This is the company's new 1908 catalogue just off the press, and should be in the hands of every user and prospective user of propellers. "This is the most complete catalogue ever issued on propeller wheels, reverse gears and accessories, and we claim to be the largest manufacturers of these specialties in the world. We sell more than all the other manufacturers combined. Marine gasoline engines are not reversible the same as a steam engine, so it has been necessary to provide some suitable mechanism to control the boat, either going ahead full speed, stopping or backing up. This is done satisfactorily by either a reversible propeller wheel or a reverse gear and solid propeller wheel. They each have their advantages and disadvantages, so it is a matter of choice to the user between the two. A reversible propeller controls the boat by changing the pitch of the blades from full pitch ahead (full speed ahead), neutral (standing still), full pitch back (reversing or backing up). The blades can be readily adjusted to suit the power and model of hull for speed. They are light in weight and occupy but little space. The hub is small and reversing mechanism of great strength and rigidity, and very simple in construction. The two and three-blade reversible wheels are designed on the same lines as our famous standard speed propeller wheels, and have the same form and pitch. They will produce the same speed. The blades are in the center of the hub, perfectly balanced and easy to operate. They are giving such universal satisfaction that they have revolutionized the use of the reversible propeller wheels. The brass sleeve rotates with the shaft, and is moved longitudinally by the reverse lever. This sleeve operates the blades and fork. The water is kept from entering the boat by an outside combination stern bearing and stuffing box, also by an inside stuffing box. Weeds, sand, etc., cannot interfere with the reversing of these wheels. It is impossible, by striking any obstruction, to injure the hub or fork so that either will refuse to reverse. The reverse lever and latch are made of heavy malleable iron, the quadrant and fulcrum of cast iron and the stern bearing, outer and inner stuffing boxes, thrust and clamp collars are of bronze. The outer tubing or sleeve is of brass, with stern bearing babbitted."

"Coe's Improved Combustion and Draft System" is the title of a booklet distributed by George H. Thacher & Company, Albany, N. Y. This device consists primarily of four main parts. "First, the balanced draft regulating mechanism controls the stack or fire damper and the admission of steam through the superheater to the jet blower, holding the boiler pressure within a variation of 3 pounds. Second, the superheater is located according to the setting of the boiler at the point where the full force of the hot gases of combustion strike it, usually directly back of the bridge wall in the return fire-tube type, or above the tubes directly in front of the first baffle plate in the water-tube type. Steam is drawn from the main line and superheated until it becomes practically a gas as it enters the blower, thus reducing the consumption to a minimum and preventing the possibility of injury to the boiler. Third, the twin tube jet blower is located in the back or side wall of the boiler, and is connected with the fire-box by suitable air ducts, through which a jet of highly superheated steam is discharged, forming a partial vacuum and drawing with it a quantity of air, giving the desired pressure under the grate, thus supplying the gases necessary for combustion. On account of the efficiency of the blower less than 3 per cent of steam is used, and in conjunction with the superheater this consumption may be materially reduced, making it the most economical forced draft system on the market. Fourth, the Coe sectional shaking and dumping cut-off grates consist of the usual bearing and supporting bars, which carry specially designed rocking frames. The design of the patented journals and the side or bearing frame into which they fit, does away with all wedges or blocks for holding grates in position. It is stated that this system may be installed in any type of boiler without change to setting; that it positively prevents formation of clinkers from the combustion of any coal; that it reduces the cost of relining furnaces of boilers 50 per cent; that it works no injury whatever to boilers, and that it gives increased rate of combustion which does not depend upon the height of the stack."

"Valves and Fittings for Ammonia" is the title of a handsomely printed and illustrated cloth-bound volume of 124 pages issued by Crane Company, Chicago, Ill. The valves and fittings illustrated in this catalogue, with the sole exception of malleable iron screwed fittings, are an entirely new line, and were designed to meet the demands of the most approved engineering practice as to standards, interchangeability of parts, proportions, thickness of metal, etc. Crane valves and fittings for ammonia are suitable for working pressures up to 250 pounds, and are subjected to an air-under-water test of 300 pounds. The company has tested different sizes of ammonia valves to 4,000 pounds without breaking.

"Flake Graphite" is the title of a booklet published by the Joseph Dixon Crucible Company, Jersey City, N. J. "Dixon's Ticonderoga Flake Graphite makes the better lubrication possible. It is the master key to the most difficult problems of lubrication. Graphite occurs naturally in two forms, the crystalline and amorphous, but the latter is usually closely associated with grit or clay, or other impurities, and is, therefore, not fit for lubricating purposes. The crystalline form is the one exclusively used for this purpose, and the foliated or thin-flake form, such as the Dixon mines in Ticonderoga, N. Y., supply in abundance, is especially valuable. Dixon's Ticonderoga flake graphite is a pure, foliated, water-dressed and air-floated American graphite. It has unrivalled smoothness and softness and endurance. It is entirely inert and not affected by heat, cold, acids or alkalies, and added to oils or greases increases their efficiency and endurance to a marvellous degree. Lubricating graphite improves the condition of the rubbing surfaces by filling up all the pores and microscopic irregularities, providing a coating or thin veneer of great endurance and remarkable smoothness. Graphite may be fed dry or mixed with water, oils or greases in various proportions according to the circumstances and requirements. We are always glad to give advice and aid as to ways of feeding graphite and the amount necessary for best results."

A Valuable Book on Rivets.—"Scientifie Facts and Other Valuable Information About Victor Boiler, Structural and Ship Rivets" is the title of a handsomely printed and illustrated catalogue of 78 pages, published by the Champion Rivet Company, Cleveland, Ohio. This catalogue contains a great deal of information of interest to users of rivets, and a free copy will be sent to every reader who will mention this magazine. Included in the catalogue are the essays on "How to Heat and Drive Good Steel Rivets," which were awarded the prizes tendered by the Champion Rivet Company at the annual meeting of the International Boiler Makers' Association, held in Cleveland, last May. There is also a report on physical and mechanical tests made of Victor Steel Rivets. These tests are all practical, and the originals may be seen in the office of the company, or if anyone desires to repeat the tests for his own satisfaction, sample rivets will be sent upon application. In the back of the catalogue is a series of illustrations showing some of the important work in which Champion rivets have been used, such as the United States cruisers *Washington* and *Des Moines*, the Great Northern steamship *Minnesota*, the Russian cruiser *Variag*, the great locomotive No. 989 made by the American Locomotive Company, the United States Custom House in New York City, various water-tube and Scotch boilers, dry-docks, bridges, office buildings, etc.

"High Speed Sensitive Drills" are the subject of catalogue No. 30, issued by the Fox Machine Company, Grand Rapids, Mich. "There is no class of machinery more widely used than sensitive or high-speed drills. While not an expensive part of a machine tool equipment they are vital nevertheless and should be carefully chosen. Their use should be much more universal than it is. Small holes cannot be drilled with a large machine without having the breakage in drills a serious matter. Wherever two or more different sized holes have to be drilled in the same piece, or drilling and tapping or reaming has to be done in the same piece a multiple spindle drill should be used so that all the work can be completed in one handling of the piece and one setting in the jig will be sufficient. A detailed comparison with all competing machines and a careful consideration of both quality and price usually leads to the placing of at least a trial order for Fox drills. We ask for nothing more."

"Asbestos Papers," "J-M Asbestos Lead Joint Runners," "Noark Fuse Plugs" and "J-M Insulated Arc Lamp Hangers" are the titles of folders recently published by the H. W. Johns-Manville Manufacturing Company, 100 William street, New York City.

Eighty Pages on Lubrication.—The actual experience of practical men and the scientific experiments of learned authorities are concentrated in Dixon's latest book, "Graphite as a Lubricant," tenth edition, published by Joseph Dixon Crucible Company, Jersey City, N. J. Every one interested in machinery will find lots of valuable information in this attractive volume. Sent free to those interested—write for copy No. 75-C.

Light milling machines are described and illustrated in catalogue No. 29, published by the Fox Machine Company, Grand Rapids, Mich. The company states that its attention was called to the fact that the field for specializing the manufacture of light milling machines was unoccupied, and that it was very apparent no one had made any successful effort to meet the special need for manufacturing light millers. After investigating the field for machines of this type the company went to work and the results speak for themselves.

"Pattern Shop Equipment" is the title of a handsomely illustrated catalogue of 64 pages, published by the Fox Machine Company, Grand Rapids, Mich. This catalogue includes a full line of tools the company places on the market, especially for pattern shop use. Prices for equipment will be sent upon application. The company issues separate catalogues of its machine tools and woodworking tools, and will forward these or any other of its catalogues upon request to any readers mentioning this magazine.

The monthly stock list issued by the Bourne-Fuller Company, Cleveland, Ohio, shows in detail the line of iron and steel materials the company has in its warehouse for the accommodation of customers whose requirements cannot await deliveries from the mills. Such shipments, however, are but a part of this company's business. Through close connections it is prepared to ship directly from the mills to its customers all orders or contracts in the way of merchant iron and steel and pig iron and coke. All of our readers who will mention this magazine will be placed on the company's free mailing list to receive the stock list regularly.

"Reliance" water columns and steam traps are the subject of literature distributed by the Reliance Gauge Column Company, Cleveland, Ohio. Regarding the company's water columns, the statement is made that over 38,000 are in daily use, that they have been on the market for years, and that they are in use in every State and Territory of the United States and in many foreign countries.

"Alundum, its Invention and Use," is the title of a pamphlet published by the Norton Company, Worcester, Mass. This pamphlet traces the development of grinding, beginning with the old-fashioned grinding stone, followed by the emery wheel up to the Norton Company's new product, called Alundum, which the company manufactures in an electric furnace plant at Niagara Falls.

Marine engines, centrifugal circulating pumps, lumber and freight hoists, marine boilers and marine electric sets and surface condensing apparatus are the subject of the 1908 supplement to catalogue No. 17, published by Marine Iron Works, Station A, Chicago, Ill. Those of our readers who already have catalogue No. 17 will certainly wish to receive this supplement. Either the supplement, the main catalogue, or both, will be sent free upon request, to those mentioning International Marine Engineering.

TRADE PUBLICATIONS

GREAT BRITAIN

Sanitary appliances are the subject of a fully illustrated catalogue of 36 pages, published by George Gennings, Ltd., 63-67 Lambeth Palace Road, London, S. E. This firm makes a specialty of sanitary appliances for marine use.

Metallic packings are described in a 70-page illustrated pamphlet published by Lancaster & Tonge, Ltd., Pendleton, Manchester. This catalogue states that "The Lancaster" patent metallic packings have been supplied to the British and many foreign navies and to the principal engineers in Great Britain and abroad. Appended in book form will be found the experience of users. The packings they refer to were all supplied on approval and guaranteed, and the company still adheres to this feature of its business.

Illustrations of machinery manufactured by W. H. Allen, Son & Company, Ltd., Queen Engineering Works, Bedford, are shown in catalogue No. 25 which this firm is distributing. This catalogue consists of several sections, giving illustrations of this firm's machinery. Section 1 is devoted to open and enclosed engines; the next section to surface and jet condensing plants; the third section illustrates centrifugal and turbine pumps, and the last section forced and induced draft fans.

"Patent Pilot Packing" is the subject of folders distributed by the Beldam Packing & Rubber Company, 93 and 94 Gracechurch street, London, E. C. "Pilot packing is a combination of asbestos and white metal, manufactured on scientific principles which ensure the following advantages: 1. The metal in the packing is concentrated on the actual wearing surface and forms a continuity of metal on the rod. 2. In actual use the pressure of the gland forces the white metal on to the rod and a series of white metal rings (asbestos protected) is formed in the stuffing box. 3. The rods are kept as smooth as glass, and cannot possibly be scored. 4. The highest temperatures do not affect this packing. 5. It is perfectly pliable and its durability is very great. Pilot packing is specially designed to stand the highest pressures, and is in use in a number of steamers, etc., working at 220 pounds and upwards. Any size supplied in lengths or in rings."

Pistons and piston valves are described and illustrated in an illustrated pamphlet published by Lancaster & Tonge, Ltd., Pendleton, Manchester. "Our piston packings have stood the test of over twenty-one years' experience, during which time over 30,000 have been sold. They secure a steam-tight piston with a minimum of friction, and are very simple in construction, whilst they are self-adjusting and reliable even in unskilled hands. They are used by many of the principal marine, stationary and traction engine builders, many specifying them exclusively. Three firms alone have had over 6,000 sets, ranging up to 110 inches diameter. Large numbers have also been supplied for marine purposes, and they are in use on some of the largest liners, the North German Lloyd having given us many repeat orders during the last few years. We still continue to supply new customers with Lancaster piston rings and springs on approval for three months' free trial, and we guarantee the efficiency of these piston packings at all pressures and speeds."

"Ships' Fittings" and "Ships' Side Lights" are the titles of illustrated catalogues published by Carron Company, Stirlingshire. These catalogues and others issued by the same company embrace almost every kind of ships' fittings and furnishings, and should be in the hands of every shipbuilder and steamship company, and a free copy will be sent to all of our readers mentioning INTERNATIONAL MARINE ENGINEERING. Regarding Carron Company's patent saloon lights and other fittings the statement is made that they are used by the leading shipping companies throughout the world and that they have been adapted by the Admiralty.

Piston rings, metallic packing, steam driers, steam traps, etc., are described and illustrated in a booklet published by Princeps & Company, Sheffield. Regarding this company's combination metallic packing the statement is made: "This is a cheap form of a floating metallic packing designed to meet any class of engine; it is designed so as to enable you to use the present gland and neck ring, and takes the place of ordinary asbestos. It is adjusted by screwing up the gland with the fingers only; this is quite sufficient to withstand 120 pounds boiler pressure. The anti-friction metal rings only are in contact with the rod, and they are free to move in any direction with the rod without breaking joint; the expansion of the compo gives the required pressure to the packing rings to keep them in contact. We have had numerous enquiries for a cheap form of a floating metallic packing that can be easily applied, which has induced us to put this packing on the market."

The "Griffin" improved patent system of low-tension magneto electric ignition is described in a pamphlet published by the Griffin Engineering Company, Ltd., Bath. "While fully recognizing the inherent advantages of the magneto as a sparking agent, the Griffin Engineering Company, Ltd., have hitherto (in view of the serious difficulties above described) refrained from fitting their motors with this system, pending their elimination. For some time past we have given special attention to these various points, and carried out a series of experiments with a view to improving and generally simplifying the entire system, with the gratifying result that under the protection of three distinct British and foreign patents, we have satisfactorily overcome all difficulties, and rendered the entire system absolutely simple and efficient, at all speeds and compressions, either high or low, and equally suitable for either single or multi-cylinder motors of any power."

Steam steering gears and ash hoists are described and illustrated in a catalogue issued by Carron Company, Stirlingshire.

Engineering specialties of many kinds, such as portable dynamometers, continuous double diagram indicators, patent pocket pitchometers and speedmeters are the subject of illustrated circulars published by Dobbie McInnes, Ltd., 45 Bothwell street, Glasgow.

"Sanitary Appliances for Ships" is the title of a very fully illustrated and handsomely printed catalogue of 138 pages, issued by Shanks & Company, Ltd., 81 New Bond street, London, W. This is the most complete catalogue in its line that we have ever seen, and it should be in the hands of every shipbuilder, ship owner and naval architect. A free copy will be sent to every reader mentioning INTERNATIONAL MARINE ENGINEERING.

"Positive Lubrication" is the title of a folder published by the Combination Metallic Packing Company, Ltd., Gateshead-on-Tyne. This company's sight feed automatic oil pump is a force feed lubricator, the oil under great pressure being forced through small tubes to the spot where it is needed. It is not a ram but a genuine reciprocating pump. It does not require the constant attention of the engineer but starts and stops with the engine. Many other advantages are claimed for this pump.

Portable electric drilling machines are described in an illustrated catalogue mailed by the Light Electric Motor Company, Ltd., Ilford, Essex. This machine is designed for engineers, shipbuilders, boiler makers, bridge builders, etc., and also may be connected to any incandescent lighting circuit. It is said that owing to the special construction of the motor no over-load cut-out is necessary; that is to say, should the drill "stop dead" in going through a hole no immediate burning out of the motor can take place.

A catalogue and price list of forgings, drop forgings and stampings is issued by the Central Marine Forge, West Hartlepool. This company makes forgings for stern frames, rudder posts and frames, keel bars, stem bars, iron and steel shafting, connection rods, piston rods and other heavy forgings in iron and steel to 17 tons in weight, and drop forgings in iron, steel, nickel steel, aluminum, copper and Muntz metal from 1 ounce to 1 cwt. in weight. Since its establishment the Central Marine Forge has made about 500 large stern frames.

"The Metallic Packing that is Used in Twenty Navies, 800 War Vessels, 1,000 Passenger and Merchant Vessels" is the title of a folder published by "Combination" Metallic Packing Company, Hillgate, Gateshead.

The 1907-8 calendar issued by the Armstrong College, Newcastle-upon-Tyne, is a volume of 400 pages. This college has complete courses in naval architecture, engineering, electrical engineering, mining, metallurgy, agriculture, pure science and letters. Full particulars may be obtained from F. H. Pruen, Esq., secretary of the college.

"Lion" packings are the subject of a catalogue published by James Walker & Company, "Lion" Works, Garford street, West Indian Dock Road, London, E. This firm makes a specialty of packing for steam hammers, "Poplar" packings for low-pressure, circulating and air pump valves, and, in fact, all kinds of packing.

BUSINESS NOTES

AMERICA

"A NEED BRINGS FORTH A REMEDY."—That a remedy is necessary when making up a pipe joint is the statement made by the Edgecombe Company, Cuyahoga Falls, Ohio, and the remedy it offers is its "Red Cross" pipe joint compound. The company states that "science has not been able to produce a steel which will not wear, and it is evident that the only way to solve this problem is to use some material which will fill the spaces when making up the joint. If we could find a material as lasting as the pipe itself the joint would be as perfect as a jointless pipe. In the past we have depended upon red and white leads to accomplish this result, but neither has ever done it. Both are poisons. Both are chemical compounds and readily decomposed by the electric current, and neither of them has the body requisite to insure life—they are simply thick paints that dry hard, and you have to break the fitting to take down a joint. Modern research has produced a material which will fill all these spaces, even the minute ones, and with a material as durable as the iron itself, as it cannot be destroyed or changed in form. Red Cross Pipe Joint Comnound is warranted to do all this. It is sent to any person with an agreement that if it does not fully fill the bill you are under no obligations to pay for it, or if you did pay for it your money is returned."

THE MACKINNON BOILER & MACHINE COMPANY, Bay City, Mich., is installing additional machinery in its boiler works, consisting of a Kling rotary shears, capacity ¾-inch plate; Lennox bevel shears, capacity ¾-inch plate; Whiting punch, 48-inch throat, with structural jaw, and a high-speed cold saw with a capacity of cutting a 15-inch 42-pound beam in 28 seconds.

THE PENBERTHY INJECTOR COMPANY, Detroit, Mich., was organized in 1886. "The president of the company, Mr. S. Olin Johnson, was at that time the general manager of the Detroit Knitting & Corset Works. The inventor of the original Penberthy injector was one William Penberthy, of Leadville, Col., who on his way East stopped at the exposition at Chicago, held during that year, where he saw an exhibit of an automatic re-starting injector, which so interested him that he devised what he thought to be an improvement. This injector was brought to the attention of Mr. Johnson, a test was made, which proved fairly satisfactory and a patent was applied for and granted. Mr. Johnson set aside in the building of the corset works a room about 20 by 30, and installed therein a tool lathe and two brass lathes and began the manufacture of the injector which was at the time of the organization of the company called Penberthy. It is a matter of history unknown to the general public that the injector, so called, and invented by Mr. Penberthy was an absolute failure. There were 170 of these injectors made, and within sixty days after they were sent out they were recalled and melted up. In the meantime the company had improved on the original injector, manufacturing 4,000, which proved very satisfactory. Experiments developed another still better machine, of which some 12,000 were made and sold. At about this time the superintendent of the company, Mr. Thomas J. Sweeney, invented the injector that has since then been sold by the Penberthy Injector Company throughout the world, no changes having been made after the first 16,000 were manufactured. The business of this company extends all over the world. There is no country of any importance on the globe to which Penberthy injectors have not been sent." In addition to injectors, the company manufactures a large line of boiler and engine room appliances, such as lubricators, oil and grease cups, water gages, gage cocks, etc., all fully illustrated and described in a 70-page catalogue which will be sent free to readers mentioning this magazine.

MORTUARY VAULTS AND ANTI-MARINE BURIAL ASSURANCE.—In spite of the great increase in the size and magnificence of ocean-going passenger steamers during recent years, there is one feature which has not kept pace with the advance of improvements in the service in general. We mean facilities for taking care of the bodies of passengers who die at sea. The present mode of disposing of the bodies of passengers who die on board ship is either to drop them overboard, or in some unsatisfactory or make-shift manner to preserve and land them; in the latter case with much trouble to the steamship company and at great expense to the family of the deceased. To remedy this state of affairs, Mr. Walter S. Upshur, Newport News, Va., has invented and patented a mortuary vault and coffin, and has copyrighted a form of anti-marine burial assurance to be issued to passengers on steamers installing the mortuary vaults and coffins. In the contract, the steamship company using Mr. Upshur's mortuary vaults will, in the event of the passenger "dying aboard said steamship during said voyage, preserve his body aboard said steamship until arrival at the port of ———, where it will be embalmed, placed in a hermetically sealed metallic casket and disposed in the receiving vault for a period of ten days, or such less time as may be necessary for the ——— steamship company to communicate with" the relatives of the deceased, and to ascertain what disposition they wish to be made of the body. The steamship company also agrees at the expiration of the ten days either to inter the body in an appropriate manner free of additional cost at the port of arrival, or, at the request of the relatives of the deceased, to return it to the port from which the dead passenger embarked. The suggested cost of this assurance is $5.00. The vaults will be constructed of mild ship steel, commercial shapes being used. The refrigerating coils are to be made of wrought iron galvanized pipe, secured in racks on the inside of the frame, and the vaults will, of course, be air-tight and furnished with a suitable thermometer. The caskets will be 7 feet long, lined with zinc and made water-tight. The public has been made familiar through the newspapers during the past few months with several very distressing cases of burial at sea, so that this invention of Mr. Upshur's is likely to attract the favorable attention of steamship companies as well as passengers. Attention is called to his two-page advertisement in this issue of INTERNATIONAL MARINE ENGINEERING.

Regarding Hanna riveters, made in any style, any size and any pressure, for all riveting purposes, the Hanna Engineering Company, 820 Elston avenue, Chicago, Ill., makes the following claims: "Hanna riveters drive absolutely tight rivets with every stroke, because maximum pressure is reached at one-half piston travel and uniformly maintained throughout balance of stroke. No adjustment necessary for ordinary variations. You cannot obtain tight rivets without a known pressure; we give it to you. Obviate entirely the necessity of cutting out and redriving loose rivets. Reduce the cost of pneumatic hammer riveting fully one-half. A practical substitute for the hydraulic outfit at materially reduced initial cost. Price within the reach of the smallest boiler or structural shop. Hydraulic results guaranteed, due to the Hanna motion; it is distinct. Don't confuse it with any other. There is nothing else like it. Every riveter carries with it the guarantee of Hanna results. Any riveter user can tell you what that means. In asking for prices, etc., give reach, gap, size of rivets and class of work."

Ajax Bull Babbitt is the name the Ajax Metal Company, Philadelphia, Pa., has given to a special brand of babbitt metal made exclusively by that company, and is always poured into ingots having on their upper faces the impression of a bull's head. "This metal was designed for general purposes and answers in ninety-nine cases out of a hundred where genuine babbitt is being used. It is a babbitt costing only about half as much as genuine, and in most cases will do better work. It can be used for all bearings except those carrying an extremely heavy load, and will run cool at any speed. We are selling tons of this metal every month, and it is giving entire satisfaction wherever used."

Concerning Lifting Magnets.—With the exception of articles which have appeared from time to time in a few technical publications, very little has been printed on the subject of lifting magnets. Those interested in these labor-saving devices will therefore welcome a 32-page pamphlet just issued by the Cutler-Hammer Clutch Company, Milwaukee, Wis., in which the subject is fully treated. The booklet in question contains a number of full-page illustrations, showing lifting magnets handling pig iron, steel stampings, castings, scrap and other material, together with diagrams, data on current consumption, information on lifting capacity of magnets, etc. A new cable take-up device is also pictured and described, and reference is made to the Cutler-Hammer system of control, by which the strong inductive reaction, or "kick," which occurs when the circuit is suddenly opened on a magnet coil, is automatically shunted to a discharge resistance, thus protecting the magnet insulation by dissipating the energy of the induced voltage outside of the coil itself.

A prismatic water gage for marine, stationary and locomotive boilers has been placed on the market by the Ashcroft Manufacturing Company, 85 Liberty street, New York City. This gage has been designed to meet the demand for a gage which would overcome the disadvantages of the ordinary gage glass and other gages of this type. The construction and points of superiority are stated by the manufacturer to be as follows: "The glass and its casing are so designed that the water shows black and the steam space takes on a silvery appearance, which makes it impossible to mistake the water level. In the ordinary water-gage glass it is often impossible to see at all the water level, especially if the boiler has a tendency to foam The glass in the Ashcroft prismatic water gage is a flat glass of peculiar design, quality and temper, and will not break even under the highest pressures and sudden changes of temperature. The frequent breakage of glasses in the locomotive cab or the boiler room of a stationary plant results, in many cases, in injury to men there; also in considerable expense in renewals. The opening in the front of casing is shaped to give the maximum angle of vision. The frame in which the glass is mounted consists of a front and back casting, each with a seat accurately machined to a true surface for back gasket and front pad, which are interposed between the finished surfaces and glass. This insures tight joints—very important features. The back and front castings are clamped together by a liberal number of cap screws to give a well distributed pressure on the packings and glass—an essential point to insure a tight gage. Both the back and front castings are of unusually stiff section and the back is heavily ribbed to insure its remaining straight and true under all conditions. The metal used in these castings is the highest grade steam bronze mixture throughout, and the quantity and distribution of the metal is such that they are proof against strain and distortion under all conditions. This is probably the most distinctive feature of the Ashcroft gage."

ELISHA WEBB & SON COMPANY, ship chandlers and engineers' supplies manufacturers, have removed to 136 South Front street, Philadelphia, Pa.

MR. WILLIAM S. LOVE, who for the past eight years managed the business of the Wheeler Condenser & Engineering Company in the Central West, and who has been in New York for the last year as general sales manager, will resume charge of the Chicago office of the company at 1137-8 Monadnock building on Jan. 1, 1908. Mr. Love's large circle of friends and acquaintances will be pleased to again receive his direct personal attention in this large and important territory.

MARINE UNDERWRITERS AND SUBMARINE SIGNALS.—It is of the highest importance to marine underwriters to know what ships are receiving submarine signals, so that they can justly estimate the risk on a vessel and cargo. For this reason the American Bureau of Shipping will note the fact of such equipment in the 1908 edition of the *Record of American and Foreign Shipping*. In connection with the name of each vessel having the submarine signal apparatus the abbreviation "Sub. Sig." will be printed. Also the Bureau will keep on file full information in regard to additional vessels and stations equipped, so that underwriters and others can always keep themselves informed as to the advances in safety of navigation made by the extension of submarine signals.

THE RYERSON STAYBOLT CHUCK, made by Jos. T. Ryerson & Son, Chicago, Ill., is designed for the rapid insertion of staybolts either by means of an air drill or other available power. "Its use does away with the necessity of squaring the ends of the bolts, which is the usual practice at the present time, while its arrangement is such that it is always available for any size stay-bolt, without adjustment. The gripping device is absolutely positive in its action, thus precluding any possibility of the bolt slipping while it is being screwed into the sheet. When a stay-bolt has been inserted in the sheet it can be instantly released from the chuck by simply turning it in the opposite direction. The chucks are fitted with Morse taper shanks for standard sizes of air drills and are so simple in construction that it is almost impossible for them to get out of order. The chuck consists of two parallel circular plates secured together by means of bolts, the middle portions of which are larger than the ends, so as to form shoulders for the plates to rest upon. These bolts also serve as pivots for the grippers. Eeach gripper consists of a segmental gear extended at one end to form a cam, and provided with a curved serrated face to grip the stay-bolt which is inserted through the hole in the middle of the chuck. The gears intermesh with teeth mounted between the two plates. The teeth are arranged so that they will swing like a pivot when the shank is turned. From this it will be readily seen that when the power is applied to turn the chuck, the teeth will grip tighter, and as the resistance increases the grip will increase in proportion to it. This, as has been stated above, makes it absolutely impossible for the bolt to turn in the chuck when in use. The Ryerson chuck is made of the best material throughout, and each is thoroughly tested before leaving the shop. Prices and full particulars will be furnished on request."

BENJAMIN WIRELESS CLUSTER PATENT SUSTAINED.—Friday, November 15, 1907, the Circuit Court of Appeals for the Second Circuit (Judges Lacombe, Coxe and Ward), rendered a decision sustaining claims five and seven of the Benjamin Wireless Cluster patent No. 721.774, dated March 3, 1903. The suit was that of the Benjamin Electric Manufacturing Company against the Dale Company and John H. Dale, and involved the Dale multiple wireless cluster, which was first placed upon the market by the Dale Company in the spring of 1904. The case originally came before Judge Holt, of the Circuit Court, and he sustained the validity of the Benjamin patent, but he held that the Dale cluster did not infringe. The Court of Appeals, while confirming Judge Holt as to his finding of validity, reverses the lower court on the question of infringement and finds that the Benjamin patent as to claims five and seven is infringed by the Dale wireless cluster. A second suit brought by the Benjamin Electric Manufacturing Company against the Dale Company and John H. Dale concerns the series wireless cluster marketed by the Dale Company. An order has heretofore been entered in this second suit providing for an injunction and accounting as to the Dale series cluster in case the court entered an injunction and an accounting as to the multiple cluster involved in the first suit. The litigation has been closely contested by both sides, and has occupied the attention of the courts during the past three years. Complainant was represented by the firm of Jones, Addington & Ames (William H. Kenyon and W. Clyde Jones of counsel), and the defendants by Rosenbaum & Stockbridge. The company's line of wireless clusters thus sustained by the courts of last resort is extensively used in marine lighting, and said to be admirably adapted for this purpose.

The Hauck patent burners and oil-burning appliances, made by the Hauck Manufacturing Company, Richards street and Hamilton avenue, Brooklyn, N. Y., have been installed in many ships of the United States navy and in shipyards and repair shops throughout America. A copy of this company's catalogue will be sent upon request to any of our readers.

Mr. George A. Gallinger, heretofore traveling from the Chicago office of the Independent Pneumatic Tool Company, has been appointed manager of the company's Pittsburg office at 1210 Farmers' Bank building. The Independent Pneumatic Tool Company now carries, in Pittsburg, a complete line of Thor pneumatic tools and spare parts.

The Nicholson speed indicator is designed to tell the speed of motor boats. The hand points to the speed the boat is making through the water at the time of observation. Every variation of speed will instantly be shown on the dial. The same principle is used in installing on motor boats as on large steam ships. This indicator is made by the Nicholson Ship Log Company, Cleveland, Ohio.

The Puzzle of the Suspended Ball.—The American Blower Company's exhibit at the recent annual convention of the American Street and Interurban Railway Association and its allied associations at Atlantic City was exceptionally interesting. The suspended ball feature which attracted so much attention at the M. M. and M. C. B. conventions in June, proved equally interesting to the street railway officials and their friends. The visitors worked their slide rules in vain in an effort to determine why the ball retained its position, and the real explanation had to be often repeated by the representatives in charge. Any one sufficiently interested in this unusual phenomenon to desire an explanation can secure same by addressing the American Blower Company at Detroit, Mich.

The general offices of the Wheeler Condenser & Engineering Company will be removed from 90 West street, New York, to the works at Carteret, N. J., on Jan. 1, 1908, and all the present New York employees transferred there. The company is erecting a very extensive addition to its present office building in Carteret to accommodate the increased force and to provide room for the executive offices. The drawing room will be enlarged and occupy practically the entire upper floor of the office building, while additional room will also be provided for the engineering department proper. A kitchen from which luncheon will be served at noon will add to the comfort and convenience, and also give that opportunity for the heads of departments to meet daily, which has been found of such value and help in similar large establishments.

A Free Sample of Paint.—Crysolite paint conquers corrosion, according to Semet-Solvay Company, Syracuse, N. Y., which makes the following statement: "Making paint is not our business, but we are operating eleven retort coke oven plants, which contain an immense amount of structural iron and steel, and numerous corrugated iron buildings, metal roofs, steel stacks, storage tanks, etc. We found, if we did not wish to rebuild our plants every few years, we would have to paint them with something better than we could buy. Our technical men took up the problem and after much experimenting produced Crysolite. It has saved us a large sum of money, protecting our plants very efficiently under a great variety of severe conditions. Possibly it is just the material you are looking for, and the only way to find out is to try it. A sample will be sent, without charge, to any responsible party, and full information given to any one interested."

Vessels classed and rated by the American Bureau of Shipping, 66 Beaver street, New York City, in the *Record of American and Foreign Shipping:* American schooner *William M. Mills*, American schooner *Nassau*, British schooner *Scotia*, American schooner *Oneida*, British schooner *Princess of Avon*, American schooner *Agnes Manning*, American schooner *Samuel W. Hathaway*, American schooner *N. E. Ayer*, American schooner *Hannah F. Carleton*, American schooner *Dean E. Brown*, American schooner *Three Marys*, American schooner *Elvira Ball*, American 3-masted *William W. Converse*, British 3-masted *Hieronymus*, British 3-masted *Rescue*, American 3-masted *John J. Hanson*, British 3-masted *Leonard Parker*, British 3-masted *Roseway*, British 3-masted *Evelyn*, American 3-masted *Charles Noble Simmons*, American 3-masted *Horatio L. Baker*, American 3-masted *Daisy Farlin*, American 3-masted *Francis V. Sawyer*, American brig *Glendower*, American Brig *Merriam*, American brig *Preston*, American brig, *Pocomoke*, American brig *Burnside*, American brig *Suffolk*, American brig *Lincoln*, American brig *S. T. Co. No. 4*, American barkentine *Rachel Emery*, American half bark *John McDermott*, Mexican half bark *Iona*, Russian *Laine*.

AN UP-TO-DATE POWER PLANT.—What is stated to be the most up-to-date, and for its size the most economical, power plant in the United States, is that of the Philadelphia Auto Transit Company, at 31st and Dauphin streets, Philadelphia. This plant furnishes power for charging the storage batteries of the auto transit company's big electric automobiles. In describing the mechanical equipment of the plant it will perhaps be well to start with the boilers. These are of the Heine water-tube type, fed by two C. H. Wheeler feed pumps—one always in reserve—and furnish steam at 165 pounds per square inch pressure for three 150-horsepower De Laval steam turbines, each driving two 50-kilowatt generators. The exhaust from all the engines can be turned into either a condensing or non-condensing header, and in cold weather the exhaust from one turbine will be used for heating the building. Ordinarily, however, all the turbine exhaust goes to the condenser, the exhaust from auxiliaries being sufficient for the feed heater needs. The efficiency of a turbine-driven plant is so entirely dependent upon a good vacuum that in this installation the condenser was selected with especial care; and its performance so far has amply justified the choice. It is the C. H. Wheeler improved type with 1,500 square feet of cooling surface, and a condensing capacity of 12,000 pounds of steam per hour. The vacuum is maintained by a Wheeler-Mullan suction valveless air pump. This pump removes both air and water in one operation, is extremely simple and compact, and, having no fragile parts, is almost impossible to damage. It is guaranteed to hold a 28-inch vacuum under normal conditions, and because of this high vacuum capacity is especially valuable for turbine installations. Since city service water is too expensive to be used at the rate of 1,000 gallons per minute for cooling in the condenser, a notable economy has been attained by the installation of two Wheeler-Pratt cooling towers. These are located on the roof of the building, and cool 1,000 gallons of water per minute from the condenser temperature to about 75 degrees F., depending upon weather conditions. The water is circulated through the condenser and elevated to the top of the towers by two centrifugal pumps; one, for ordinary loads, is of 15 horsepower, driven by a De Laval steam turbine, and a second, for lighter loads, is 5 horsepower and motor driven.

BUSINESS NOTES

GREAT BRITAIN

AN ORDER HAS BEEN SECURED by Messrs. Richardsons, Westgarth & Company, Ltd., for a 450-horsepower gas engine for using producer gas at the Mitsu Bishi Dockyard, Kobe, Japan.

MESSRS. HAWTHORN, LESLIE & COMPANY, engineers and shipbuilders, Newcastle and Hebburn-on-Tyne, have been awarded the Grand Prix for their exhibits of ships' models at the International Exhibition at Bordeaux.

LOWE & FLETCHER, ADMIRALTY CONTRACTORS, combination works, Church street, Willenhall, Staffs, occupy very extensive premises and carry a large stock of all classes of ships' locks.

EDWARD HAYES, Stony Stratford, has recently received orders for steel plated launches and tugs, and marine engines and boilers for the Nile, Jamaica, Ivory Coast, Delagoa Bay, Persia and Sierra Leone.

A THIN TUBE BENDING MACHINE is made by M. A. Hughon & Company, 9 Connaught street, London, W. This machine and its steel ball articulating mandrels are patented, and the claim is made that with it no resin or lead is required; no loading and no filling of any sort. All the bends are made cold, unloaded, at an average of a few hundred a day by a single mechanic hand.

EXHIBITION HONORS FOR CLYDE BUILDERS.—Messrs. William Simons & Company, Ltd., Renfrew, have been awarded the Grand Prix at the Bordeaux International Exhibition for their exhibits of dredging plant and elevating deck steamers. Messrs. the London & Glasgow Shipbuilding Company, Govan, and Messrs. Alex. Stephen & Sons, Linthouse, have been awarded similar honors.

THE GRAND PRIX has been awarded by the Exposition Maritime de Bordeaux to Heath & Company, Crayford, London, S. E., for its exhibition of mathematical, nautical and scientific instruments. A full account of this company's exhibition is contained in *Le Bulletin Universel des Expositions*, dated Sept. 10. Those interested may secure a copy by writing the Messrs. Heath & Company. The above mentioned article in the *Bulletin* states: "It is the English (incomparable navigators) that possess the best instruments." The article goes on to state that the exhibition of Heath & Company is most remarkable. Three pages and several illustrations are devoted to this company's products.

The amalgamation is announced of the engineering firms, Applebys, Ltd., and the Temperley Transporter Company. These firms are well known as manufacturers of cranes and transporting machinery of every description, specializing in shipyard, dock and harbor equipments, steel works, coal handling and contractors' plant. The amalgamated firms will trade under the title of Applebys, Ltd., with offices at 58 Victoria street, Westminster, and works at Glasgow and Leicester.

The patent protective lubricating box for propeller shafts, manufactured by F. R. Cedervall & Söner, Gothenburg, Sweden, has been sanctioned by the Board of Trade, by Lloyds, Bureau Veritas and Norwegian Veritas, and applied to numerous steamers classed in their books. This patent has been applied to ships of war in several navies and fitted to numerous steamers in the Atlantic Ocean, Baltic, North, Caspian and Black Seas. Among the advantages claimed for the invention are the following: "Increases the number of revolutions of engines; enables tail-end shaft to be efficiently lubricated by oil; prevents sea water and grit from entering the stern tube; costly brass liners on shaft and lignum vitæ bearings are dispensed with; galvanic action practically eliminated; maximum safety against breakdowns to propeller shafts."

Improved Patent Oil Cabinets for Ships' Use.—The manufacturer of these cabinets, the Valor Company, Ltd., Rocky Lane, Aston Cross, Birmingham, states that this is the only perfect system for keeping all kinds of oil on ships for daily use. The cabinet is made of terne coated steel with galvanized iron bottom, and is of the best finish and workmanship throughout. Being enamelled bright red, it is attractive in appearance and is unaffected by weather or oil. It shuts up and is dust proof and air tight. The pump is made of polished brass, simple in construction and cannot get out of order. It is screwed into place and may readily be taken out for filling the cabinet from a barrel. Its action is so easy that it can be worked with one finger. The oil will fill a 1-gallon measure in twelve seconds, and may be obtained without stooping down.

A Motor Boat to the Rescue.—A most lamentable accident took place recently at Burra Island, Shetland, when a small boat carrying seven fishermen was crossing from Scalloway. There was a strong sou'wester blowing and the boat was soon in difficulties, and eventually capsized about 100 yards off Boronaness. The sea and wind were getting worse, and medical aid was necessary for one of the survivors picked up by the *Qui Vive*, another Scalloway boat, summoned by telegram. Dr. Prested started off on Mr. Garriock's motor boat. The sea was, however, so heavy that off Turgar Point the ignition was swamped, and she had to run into Coldhame Bay. Here, however, the steel-built Ailsa Craig motor boat *Barney*, belonging to Mr. Andrew Smith, came to the rescue, and soon both motor boats were away at top speed for the scene of the accident, conveying the urgently needed medical help and proving themselves eminently useful. *Barney* is a seagoing cruiser doing a 10-knot speed with her Ailsa Craig engine, manufactured by the Ailsa Craig Motor Company, of Chiswick, London, and was built by the John Duthie Torry Shipbuilding Company, of Aberdeen. She will live in the wildest weather and seems unsinkable.

Trial Trip of Steamship Mars.—Oct. 9, the steel screw steamer *Mars* proceeded on her official trial trip off Hartlepool. She has been built to the order of Messrs. Harris & Dixon, Ltd., London, by Messrs. Furness, Withy & Company, Ltd., Hartlepool. The vessel exceeds 360 feet in length, has large measurement capacity and classed 100 A-1 at Lloyds. She is built on the deep frame principle with single deck, poop, bridge and forecastle, clear holds for the stowage of bulky cargo, the hatches being large and worked by six powerful steam winches, double derricks being fitted to each hatch. Cellular double bottom extends all fore and aft, the fore and after peaks are also available as water ballast tanks. Wood shifting boards are fitted throughout, and a direct steam patent windlass, large multi-tubular donkey boiler, steam and hand steering gear, fresh water condenser and all the most up-to-date auxiliaries are included in the vessel's outfit. Accommodation for the captain and officers is provided in large deckhouses on the bridge deck, the crew being berthed in the forecastle. She is rigged as a two-masted fore and aft schooner. The machinery and boilers have been supplied and fitted by Messrs. Richardson, Westgarth & Company, Ltd., Hartlepool, and worked most efficiently throughout the trial. The sizes of cylinders are 24-inch, 39-inch, 66-inch by 45-inch stroke, steam being supplied by two single-ended boilers, 16 feet by 10 feet 6 inches long, working pressure 180 pounds per square inch. The owners were represented by Mr. H. W. Rogers (London), the shipbuilders by Mr. F. Bolton, and the engineers by Mr. G. Urquhart.

MOTOR LAUNCHES FOR THE KING OF SPAIN and the Spanish navy. Messrs. John I. Thornycroft & Company, Ltd., Church Wharf, Chiswick, London, W., are building two motor boats for the King of Spain. One for the King's personal use and the other for his staff. They are to be 28 feet in length with a beam of 7 feet and an extreme draft of 3 feet. The speed will be 9 to 10 knots; the power in each case being 28 B. H. P. Thornycroft motors driving twin Thornycroft propellers. There will be a portable cabin amidships with a short deck fore and aft, a canvas over well and two folding canvas hoods. The cabin of his majesty's launch will be enamelled white inside, relieved with gold, and the remainder of the decorations will be in keeping. The motors will be of the new Thornycroft L-4 type, which have four cylinders each with a bore of 4½ inches and a stroke of 5 inches, and develop 28 B. H. P. at about 900 revolutions per minute on petrol. In addition to the above launches, Messrs. Thornycroft & Company have received an order for two 36-foot motor boats for the Spanish cruiser *Cataluna*.

TRIAL TRIP OF STEAMSHIP CALCUTTA.—On Nov. 1 the steamship Calcutta proceeded on her official trial trip, after adjusting compasses, in Hartlepool Bay. The vessel, which exceeds 360 feet in length, is owned by Messrs. Nelson, Donkin & Company, London, and has been built to Lloyds 100 A-1 class by Messrs. Furness, Withy & Company, Ltd., Hartlepool. She has large measurement capacity and is built on the deep frame principle, with single deck, poop, bridge and forecastle, having clear holds for the stowage of bulky cargo, large hatches, worked by six powerful steam winches, with double derricks to each hatch. Cellular double bottom extends all fore and aft, and the fore and after peaks are available for further water ballast. Wood shifting boards through are fitted and a direct steam patent windlass, multi-tubular donkey boiler, steam and hand steering gear. Fresh water condenser and all up-to-date auxiliaries are included in the vessel's equipment. The captain's and officers' accommodation is provided in large deckhouses on the bridge deck, and the crew are berthed in the forecastle. She is rigged as a two-masted fore and aft schooner. The engines and all auxilary machinery worked most efficiently throughout the trial. The main engines and boilers have been supplied and fitted by Messrs. Richardsons, Westgarth & Company, Ltd., Hartlepool, the sizes of the cylinders being 24-inch, 39-inch, 66-inch by 45-inch stroke, steam being generated in two single-ended boilers, 16 feet by 10 feet 6 inches long, working at a pressure of 180 pounds per square inch.

"ROSS'S COMPOSITIONS" is the title of a 32-page booklet published by Arthur Ross, 1 Glengall Road, Old Kent Road, London, S. E. "Ross's compositions for the prevention of the formation of scale in steam boilers, have now been supplied continuously for upwards of forty years. During that period vast strides have been made in boiler construction, and the working conditions of the present time are very different from what they were when my compositions were first introduced. The success, which from the first introduction has attended my methods, is fully maintained, and I am still able to successfully cope with the difficulties due to the formation of scale in each and every type of steam boiler. The secret of this success is to be found in the careful personal attention I give to each case, the labor to discover the cause of the trouble, and the providing of a scientific method of overcoming that trouble. While laying no claim to infallibility, I may confidently claim that where my advice and instructions have been carried out, I have hardly ever experienced a failure. I work upon exact and scientific lines, and no effort or cost is spared in the endeavor to obtain the best results. A fully equipped laboratory is maintained replete with the best apparatus for conducting the most searching analyses of feed waters, scale deposits, cylinder oils, etc. The compositions supplied are in every case specially manufactured to meet the requirements of each user, as revealed by the analysis previously made. My experience is world-wide—a life's study has been given to this special subject, in which I may fairly claim to be an expert. This knowledge and experience is willingly placed at the disposal of my customers free of charge. It is a source of personal pleasure to me to be able to obtain a first-class result, and I am proud to be able to point to so great a number. Among my customers are to be found some of the largest steam users in the world; their orders have been retained for periods of ten and twenty, and in many cases for upwards of forty years. These facts should give you confidence in placing your business in my hands, and it is hardly necessary for me to assure you that my personal attention, and the wide knowledge and experience gained by the constant grappling with these difficulties are at your disposal."

MARINE SOCIETIES.

AMERICA.

AMERICAN SOCIETY OF NAVAL ENGINEERS.
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
12 West 31st Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS.
314 Madison Avenue, New York City.

UNITED STATES NAVAL INSTITUTE.
Naval Academy, Annapolis, Md.

GREAT BRITAIN.

INSTITUTION OF NAVAL ARCHITECTS.
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.
207 Bath Street, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.
St. Nicholas Building, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORP.
58 Romford Road, Stratford, London, E.

GERMANY.

SCHIFFBAUTECHNISCHE GESELLSCHAFT.
Technische Hochschule, Charlottenburg.

MARINE ENGINEERS' BENEFICIAL ASSOCIATION.

NATIONAL OFFICERS.

President—Wm. F. Yates, 21 State St., New York City.
First Vice-President—Wm. J. Brady, Jr., 67 Mission St., San Francisco, Cal.
Second Vice-Pres.—Joseph R. Blanchett, 209 Potomac Ave., Buffalo, N. Y.
Third Vice-Pres.—Jos. B. Flach, 327 N. 4th St., Paducah, Ky.
Secretary—George A. Grubb, 1318 Wolfram St., Sta. L. V., Chicago, Ill.
Treasurer—Albert L. Jones, 289 Champlain St., Detroit, Mich.

ADVISORY BOARD.

Chairman—Wm. Sheffer, 428 N. Carey St., Baltimore, Md.
Secretary—W. D. Blaicher, 10 Exchange St., Buffalo, N. Y.
Franklin J. Houghton, Port Richmond, L. I., N. Y.

HELP AND SITUATION AND FOR SALE ADVERTISEMENTS

A GOOD EXPORT TRADE.—J. W. Brooke & Company, Ltd., Lowestoft, report that during the past few weeks they have shipped to foreign countries throughout the world, including the Argentine Republic, Siam and India, nineteen motors and three complete boats. The company reports that orders are still brisk, and that they now have in hand orders for motors for the Straits Settlements, China and other foreign countries, besides their large and increasing domestic trade.

TRIAL TRIP OF THE "CELEBES."—September 25, the large Dutch steamer *Celebes*, which has been built to the order of Messrs. The Stoomvaart Maatschappij "Netherland," of Amsterdam, by Messrs. Furness, Withy & Company, Ltd., West Hartlepool, proceeded on her official trial trip from the Tyne. The vessel exceeds 407 feet in length, and has a measurement capacity of 11,725 tons, built to highest class in Bureau Veritas. She is of the three-deck type with two steel decks laid, shelter deck erections sheathed with teak all fore and aft, and a long boat deck above also built of teak. A cellular double bottom is fitted throughout for water ballast, the fore and after peaks being also available as tanks. Six water-tight bulkheads divide the vessel into seven water-tight compartments. Special attention has been given to all discharging gear, the ship being equipped with twin masts, four derrick posts (the latter arranged as ventilators), twelve derricks and twelve powerful steam winches. These, together with six large hatchways, greatly facilitate the quick discharging of cargo. One 20-ton derrick is fitted to deal with heavy weights. The equipment also includes large multi-tubular donkey boiler, direct steam windlass, patent telemotor gear, electric light installation by Furness, Withy & Company, Ltd., patent fire extinguishing apparatus. Accommodation is provided for captain and officers in a large steel deckhouse amidships, and the crew are berthed in the forecastle. Hospitals and galleys, etc., for natives are arranged on the shelter deck aft. Awnings are arranged all fore and aft. The machinery worked most efficiently throughout the trial, and has been supplied and fitted by Messrs. Richardson, Westgarth & Company, Ltd., Hartlepool, the sizes of cylinders being 26½-inch, 43, 72-inch x 48-inch stroke, steam being supplied by three single-ended boilers 11 feet 3 inches by 14 feet, having a working pressure of 180 pounds. Messrs. Jonckheer, J. de Bruyn Kops and Burger represented the company, and Messrs. H. Withy, G. W. Sivewright and L. D. Wingate represented the builders. The vessel attained a speed of 13 knots.

LAUNCH OF STEAMSHIP WESTERWOLD.—On Oct. 22, Messrs. Furness, Withy & Company, Ltd., Hartlepool, launched the first of three large passenger steamers for the Hamburg-American line, over 366 feet in length, and built to Germanischer Lloyd and See Berufs Genossenschaft Rules. These vessels are intended for the West India trade, and will be rigged as two-masted fore and aft schooners, built on the deep frame principle with two complete steel decks and long bridge, poop and forecastle and long-boat deck fitted amidships; all weather decks are sheathed with teak. The hull is divided into ten water-tight compartments, by means of nine water-tight bulkheads fitted in accordance with German Board of Trade requirements for ocean passenger steamers. Cellular double bottom extends the full length of holds and engine and boiler space for water ballast, the fore and after peaks being also available as trimming tanks. There are five large cargo hatches worked by eleven powerful steam winches, the latter being supplied and fitted by Messrs. Furness, Withy & Company, Ltd.; seventeen derricks, two of which are capable of lifting 15 tons each. The vessels will be lighted throughout by electricity, and the installation, consisting of two dynamos, will be supplied by the shipbuilders. The equipment also includes direct steam patent windlass, patent telemotor gear, steam heaters, winch condenser, steam ash hoist, See's ash ejector, fresh water condenser, eight boats with davits of Mannessmann tube, awnings all fore and aft. The 'tween decks are arranged to carry 608 third-class passengers, and are fitted with Hoskins patent Neptune berths; thirty first-class passengers are accommodated in the bridge, and a fine dining saloon, smoking room and ladies' saloon are arranged on the bridge deck; the poop i sfitted up as a hospital. The crew are berthed in the forecastle, while the captain and officers are berthed in a large deckhouse on the boat deck. Engineers' berths, stewards, Butchers' shop, bakers' shop, galley, first-class lavatories, etc., are all arranged in the bridge deck. Insulated store rooms are fitted up in the after-hold and 'tween decks, and a refrigerating plant will be supplied by Messrs. J. & E. Hall. Triple expansion engines will be supplied and fitted by Messrs. Richardsons, Westgarth & Company, Ltd., Hartlepool, the diameter of cylinders being 25½-inch, 43-inch, 72-inch by 48-inch stroke of piston, and steam will be supplied from three single-ended boilers, 14 feet by 12 feet, working at a pressure of 200 pounds per square inch; Howden's system of forced draught will be fitted in connection with the boilers.

IF YOU WERE OFFERED

A 20% INVESTMENT

Would it take you long to get next?

The Bird-Archer Company

ARE MAKING YOU A BETTER OFFER THAN THAT

We guarantee to keep your boilers absolutely clean

Free from Oil, Scale and Grease

AND DO AWAY WITH THE NECESSITY OF USING ZINCS

For $1\frac{1}{4}$¢.

PER 500 H. P. PER HOUR

FIGURE UP YOUR CLEANING BILLS, WATER BILLS, ZINC BILLS, GASKET BILLS AND THE TIME YOUR BOAT IS LAID OFF, TO SAY NOTHING OF COAL, FOR 1/16 OF AN INCH OF SCALE MEANS 15% MORE COAL TO GENERATE STEAM. THEN CUT YOUR REPAIR BILL IN HALF, AND SEE IF YOU ARE NOT SAVING MORE THAN 20% BY USING

THE BIRD-ARCHER MARINE METALLIC BOILER COMPOUNDS

The Bird-Archer Company

OFFICES

NEW YORK, 90 West Street

SAN FRANCISCO, CAL., 1302 Call Building

CHICAGO, ILL., 86 Washington Street
BOSTON, MASS., 7 Water Street
BALTIMORE, MD., 316 N. Holliday Street
PITTSBURG, PA., 208 Diamond Nat'l Bank Bldg.

SEATTLE, WASH., 608 First Avenue
PHILADELPHIA, PA., 130 North Delaware Avenue
NORFOLK, VA., 31 Lowenberg Building
CLEVELAND, O., 729 Garfield Building

LONDON, ENGLAND, Billiter Buildings, E. C.

SAY MR. ENGINEER:

HAVE YOU EVER HAD THAT TIRED FEELING when life doesn't seem to be worth living? You feel as though you were hardly able to drag one foot after the other, and when you sit down you feel like staying put for the rest of your days; SOME FRIEND tells you what to do for it, or maybe you consult a DOCTOR, or, read of a SURE CURE for the all to the bad feelings you have. You take the dope and FEEL FIT again: You feel as though you were operating under 150 POUNDS PRESSURE without any effort at all, and BLOWING OFF RIGHT ALONG: You have got the GO-AHEAD SIGNAL good and strong.

NOW IT IS THE SAME WAY PRECISELY WITH A BOILER. When a boiler is brand new she steams fine; there is no trouble in getting her up to 150 or 200 pounds pressure, but after she has been in use for a year or so she gets a little SLUGGISH or LAZYLIKE, and the longer you use her the worse she gets, until finally, she seems ALL TO THE BAD: You cannot get her pressure up to save your life; the firemen blame it ON THE COAL; you go to the owner; the owner kicks to the coal man; he gets the best grade of coal for you, but still she is on the blink.

Has it ever occured to you that you have had that SAME TIRED FEELING YOURSELF? You could not keep your pressure: you took something that fixed you up. Now let us stand in the same position as the friend who told you about the DOPE THAT PUT YOU TO THE GOOD; Let us play the part of the DOCTOR, or maybe, you will read SOME OF OUR HOT AIR STUFF that MAKES GOOD STEAMING BOILERS; We will get your boilers back where they steam well; where they get over that tired feeling. We will put them where they will carry 150 to 200 pounds pressure without killing the firemen. It is a PIPE CINCH to run a boiler that is in good condition.

Give us the chance and we will cut out all OIL, SCALE, and GREASE and KEEP IT OUT: preventing PITTING, CORROSION and GALVANIC ACTION; SAVE your TUBES; REDUCE your REPAIR BILLS; CUT DOWN your COAL BILLS; will not cause boilers to FOAM or PRIME, and don't cut your LUBRICATION or INJURE your PACKING. SAY! LOOKS LIKE READY MONEY!! and all this

For 1¼¢

PER HOUR FOR 500 H. P. OF BOILERS.

We have a keg of our DOPE ready for you: the only thing that we are waiting for is for you to tell us where to send it, and if it does not do all we claim for it, it will not cost you a cent.

The cost of our Compound when ready for use is 7½c. per pound. Can you beat it and get the above results? We guess NIT.

Very cordially yours,

THE BIRD-ARCHER COMPANY

90 WEST STREET **NEW YORK**

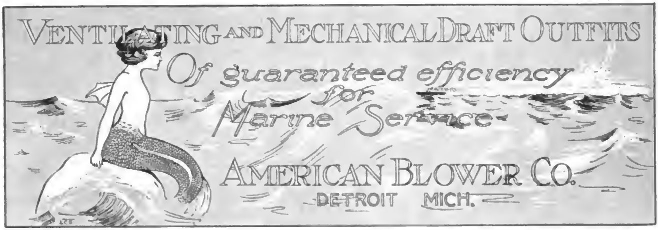
BRANCH OFFICES

EASTON, PA.
PHILADELPHIA, PA., 56 North Delaware Avenue
PITTSBURG, PA., 808 Farmers Nat'l Bank Building
CLEVELAND, OHIO, 403 Cleveland Arcade
NORFOLK, VA., 31 Lowenberg Building
HAVANA, CUBA, 67 O'Reilly Street
CHICAGO, ILL., 501 Monadnock Block

BALTIMORE, MD., 316 N. Holliday Street
GRAND RAPIDS, MICH., 3 N. Ionia Street
BOSTON, MASS., 7 Water Street
BUFFALO, N. Y., 18 Ohio Street
LONDON, E. C. ENG., Billiter Building
PORTLAND, ME. 304 Fore Street
SEATTLE, WASH. 608 1st Avenue

SAN FRANCISCO, CAL., 24-26 Steuart Street

It comes in EXTRACT form in kegs holding 60, 117 and 230 pounds at 30c. per pound. Add three parts water to one part extract and it will cost you ready for use 7½c. per pound.



This Trade Mark on Every Package

Reg. U S. Pat. Office

DOES NOT DRIP, SPLASH, OR WASTE AWAY

ALBANY GREASE

Is the Best, Cheapest, Cleanest and Safest Lubricant for Marine Machinery

CAN BE USED IN ANY STYLE GREASE CUP on the market. Will not gum, freeze, or leave sediment. Is free from impurities. Uniform in quality. Adopted by U. S Government in all its Departments

Send for FREE sample cup and can of "Albany Grease," giving diam. of oil hole, depth of oil hole from top of cap to journal, where to be used and firm's name.

MADE ONLY BY

ADAM COOK'S SONS, 313 West Street, NEW YORK

FREE TO ANY ENGINEER

A CROSBY, TABOR, AMERICAN THOMPSON, OR LIPPINCOT

INDICATOR

Also 500 other things, including every article, tool or device any engineer may want. For FREE premium list and full particulars regarding this remarkable offer, fill out and mail the coupon below to

FRANCE PACKING CO., INC.
STATE ROAD, TACONY, PHILADELPHIA, U. S. A.

Manufacturers of

**METALLIC
FIBROUS
AND
SHEET
PACKING**

FILL IN AND TEAR OFF HERE

NAME

ADDRESS

EMPLOYED BY

GIVE COMPLETE ADDRESS

LIVERPOOL AGENCY, BELLAMY, WALMER, HILL CO.

THE PARSONS MARINE STEAM TURBINE COMPANY

LIMITED

97 Cedar Street
NEW YORK

TURBINIA WORKS
WALLSEND-ON-TYNE, ENGLAND

Is prepared to grant Licenses in the United States for the building of PARSONS TURBINES for the purpose of marine propulsion.

ADVANTAGES OF TURBINE SYSTEM

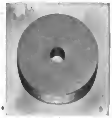
Absence of Vibration
Increased Economy in Coal Consumption
Reduced Cost of Attendance on Machinery
Reduced Consumption of Oil and Stores
Reduced Diameter of Propellers gives:
Increased Facilities for Navigation in Shallow Waters, Reduced Racing of Propellers

METAL —————— and —————— FIBROUS

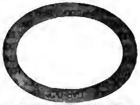
GARLOCK SPECIAL MARINE PACKINGS

VALVES, HOSE and ENGINE ROOM SUPPLIES

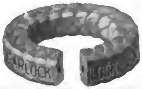
GARLOCK HIGH PRESSURE RING. STYLE No. 200



GARLOCK VALVES GRADES FOR EVERY CLASS OF SERVICE.



GARLOCK HIGH PRESSURE GASKETS. STYLE No. 604.



GARLOCK WATERPROOF HYDRAULIC COLD WATER RING. STYLE No. 99.

WRITE FOR OUR LATEST CATALOGUE

GARLOCK CUSHION CENTER HYDRAULIC HOT WATER RING. STYLE No. 275.

THE GARLOCK PACKING COMPANY

Main Offices and Factory——PALMYRA, N. Y

Philadelphia	New Orleans	New York	Boston
San Francisco	Cleveland	Chicago	Norfolk
Baltimore	Buffalo	Detroit	St. Louis

And in all Principal Inland Cities

Star Brass Manufacturing Co.

MANUFACTURERS OF

The "Non-Corrosive" Extra Heavy Renewable Seat and Disc Globe and Angle Valve

Specially adapted for High Pressures and Temperatures.
Bodies made of the highest grade Semi-Steel.
All parts renewable, including Seats and Discs.
Seats of solid nickel, Discs of special bronze.
Valves can be repacked wide open with full pressure on.
All Valves tested to six hundred pounds hydrostatic pressure before shipment to customers.
Also Renewable Seat and Disc Brass Body, Globe, Angle, Cross, Check and Blow-Off Valve.

MAIN OFFICE AND WORKS:

108-114 EAST DEDHAM STREET, BOSTON, MASS.

London Office: 28 New Bridge Street, E. C.

NEW YORK:	CHICAGO:	PITTSBURGH, PA.:	MONTREAL:
70 Cortlandt Street	56 Fifth Avenue	525 Third Avenue	180 St. James Street

—WHITE-FORSTER—

WATER TUBE BOILERS

MANUFACTURED BY

J. SAMUEL WHITE & COMPANY, Ltd.

EAST COWES, I. O. W.

110,000 I.H.P. supplied to British, Japanese, American, Russian, Italian, Austrian and Chilian Navies, Crown Agents for Colonies, National Lifeboat Institution, &c., &c.

SPECIAL FEATURES:—SIMPLICITY, FACILITY FOR REPAIR, EFFICIENCY

All Tubes of same Curvature—reducing Spare Gear to a minimum. Any Tube can be renewed without disturbing remaining Tubes or any other part of the Boiler or Ship. Tubes easily cleaned.

White-Forster Water Tube Boilers of 2,000 I.H.P.

PRACTICAL MARINE ENGINEERING

FOR

MARINE ENGINEERS AND STUDENTS

WITH

Aids for Applicants for Marine Engineers' Licenses

By PROF. W. F. DURAND

SECOND EDITION, PRICE $5.00 (21/-)

THIS BOOK is devoted exclusively to the practical side of Marine Engineering and is especially intended for operative engineers and students of the subject generally, and particularly for those who are preparing for the examinations for Marine Engineers' licenses for any and all grades.

The work is divided into two main parts, of which the first treats of the subject of marine engineering proper, while the second consists of aids to the mathematical calculations which the marine engineer is commonly called on to make.

PART I.—Covers the practical side of the subject.

PART II.—Covers the general subject of calculations for marine engineers, and furnishes assistance in mathematics to those who may require such aid.

The book is illustrated with nearly **four hundred diagrams and cuts** made specially for the purpose, and showing constructively the most approved practice in the different branches of the subject. The text is in such plain, simple English that any man with an ordinary education can easily understand it.

FOR SALE BY

INTERNATIONAL MARINE ENGINEERING

17 Battery Place, New York, U. S. A.

Christopher Street,
Finsbury Square, E. C., London, England

ECONOMY IN STEAM PRODUCTION

Highest Boiler Efficiency

Absence of Smoke with Soft Coal

Ellis & Eaves Induced Draft

In use in the merchant marine of all countries.

May we explain to you the system in detail and refer you to users of it?

For Full Particulars Address

JOHN BROWN & CO., LTD.

15-25 WHITEHALL ST. NEW YORK

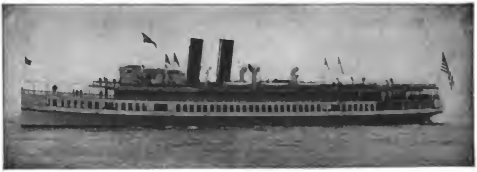
W. CARLILE WALLACE, American Representative

WORKS, SHEFFIELD, ENGLAND

The Roberts Water Tube Boiler

FOR HIGH CLASS MARINE SERVICE

TWENTY-FIVE YEARS IN USE AND STILL A SUCCESS



STEAMER ASBURY PARK EQUIPPED WITH NINE ROBERTS BOILERS

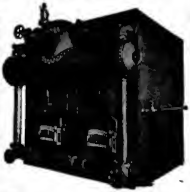
THE PIONEER
BOILER OF ITS TYPE

THE ROBERTS SAFETY WATER TUBE BOILER CO.
39 and 41 Cortlandt Street, New York City
PHONE, 899 CORTLANDT WORKS, RED BANK, N. J.

"THE PERFECT MARINE BOILER"

200 points of superiority, satisfying the requirements of the most approved steam boiler practice, make the Taylor Boiler the most economical, the most durable, the lightest, the most powerful, the most efficient, and the easiest steaming boiler extant. It has the greatest feed endurance of any boiler made. It realizes the most complete combustion, and the greatest heat absorption—due to its furnace combustion chamber and flue design—and is of the free circulation type. The tubes are interchangeable and are easy of independent removal. Send for catalogue with full description.

TAYLOR WATER TUBE BOILER CO.
345 FRANKLIN ST., DETROIT, MICHIGAN



FOSTER SUPERHEATERS

Save heat-waste and coal bills and promote the highest efficiency of boilers, engines, and turbines.

SEND FOR FREE CATALOGUE

Installations include all types of boilers and show economies of 35 to 50% net annually on cost of superheating equipment.

POWER SPECIALTY COMPANY 111 BROADWAY NEW YORK

THE ROOKERY, CHICAGO. 10 POST OFFICE SQUARE, BOSTON.
LAND TITLE BUILDING, PHILADELPHIA.

TRADE
PENBERTHY
MARK

AUTOMATIC INJECTORS

1886-1907 WIN THE LAUREL WREATH Sales 500,000

The World's Standard Boiler Feeder

MANUFACTURED BY

PENBERTHY INJECTOR COMPANY

(Largest in the World)

DETROIT, MICH., U. S. A.

Branches: NEW YORK, N. Y.; LONDON, ENG. Canadian Factory: WINDSOR, ONTARIO, CAN.

POSITIVE SHIP VENTILATION

IS SECURED BY STURTEVANT ELECTRIC FANS

They can be placed just where wanted with regulating rheostat in a convenient location. Motors of enclosed dust-proof type for the fire room, or semi-enclosed for other parts of the ship.

For ventilating the Battleship "New Hampshire" the B. F. Sturtevant Co. furnished 25 electric fans, 9 of which are shown here.

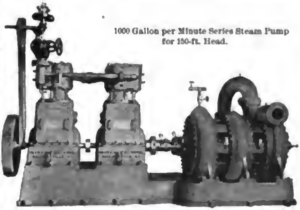
B. F. STURTEVANT CO., Boston, Mass.

GENERAL OFFICE AND WORKS, HYDE PARK, MASS.

NEW YORK PHILADELPHIA CHICAGO CINCINNATI LONDON

Designers and Builders of Heating, Ventilating, Drying and Mechanical Draft Apparatus; Fan Blowers and Exhausters, Rotary Blowers and Exhausters; Steam Engines, Electric Motors and Generating Sets; Pneumatic Separators, Fuel Economizers, Forges, Exhaust Heads, Steam Traps, etc. 632

1000 Gallon per Minute Series Steam Pump for 150-ft. Head.



Buyers of our Centrifugal Pumps and Marine and Stationary Engines have our Guarantee back of them, backed by 42 years of experience.

We are the Oldest and Largest Builders of Steam Pumps in America.

Write for Free Catalogue

Morris Machine Works

Baldwinsville, N. Y.

THIS TYPE OF AUTOMATIC

WORM GEARED STEERING ENGINE

can be located in any desired part of the ship.

Steering engines and gears, hoisting engines winches and all kinds of ships' auxiliary machinery.

Catalogue free

WILLIAMSON BROS. CO.

PHILADELPHIA, PA., U. S. A.

(SEE NEXT PAGE)

THE GRISCOM-SPENCER COMPANY

90 WEST STREET, NEW YORK CITY

FORMERLY THE JAMES REILLY REPAIR AND SUPPLY COMPANY

229-230 WEST STREET, NEW YORK CITY

(Established 1867)

Telephone, private switchboard to all departments
New York Office, 7461 Cortlandt

Telephone, Jersey City Works
1520 Jersey

Telephone, Philadelphia Works and Supply House
Main 1119 Lombard 2292

Marine Contractors-Engineers

MANUFACTURERS MARINE MACHINERY

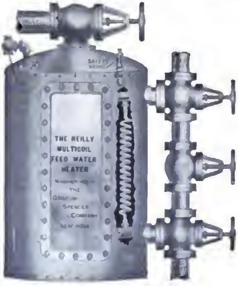
WHARFAGE FACILITIES AND SHOPS

Jersey City:
Pier B, N. R. (1 block from P. R. R. Terminal)

Philadelphia:
American-Red Star Piers (Foot Washington Avenue)

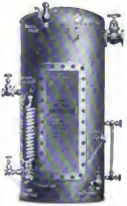
Boiler Shop, Coppersmithy, Carpenters and Ship Joiners, Machine Shop, Brass Foundry, Pipe Fitting, Forge and Steam Hammers, Sheet Metal Shop, Electrical Repairs

MARINE SPECIALTIES



Reilly Multicoil Feedwater Heater

Reilly (Ebsen) Grease Extractor

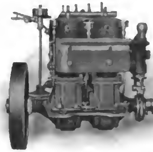


Reilly Multicoil Evaporator

SMALLEST——LIGHTEST——BEST CONSTRUCTED——MOST EFFICIENT

WRITE FOR CATALOGUE

T & M QUALITY



Engines that start and reverse on the spark

AT ALL THE BOAT SHOWS

Send for Catalog stating sizes you are interested in

TERMAAT & MONAHAN CO.

OSHKOSH, WIS.

Export Office, B 21 Produce Exchange, New York

ELECTRIC GASOLINE AUTO-BOATS

HIGHEST GRADE MATERIAL AND WORKMANSHIP
TWELVE YEARS' EXPERIENCE

166 BOATS of various sizes up to 95 feet BUILT, EQUIPPED and SOLD since January 1, 1904

YACHT STORAGE
MARINE RAILWAY

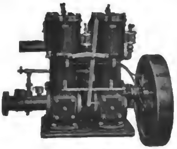
THE

ELECTRIC LAUNCH CO.

Telephone 119 Bayonne

BAYONNE CITY, N. J.

Member of the National Association of Engine and Boat Manufacturers



BARBER

JUMP SPARK MARINE GASOLINE ENGINES

Easily started. Run in either direction. Speed Control.

Material, Workmanship and Running Qualities Guaranteed

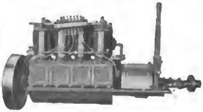
also

Barber Three Blade Reverse Wheels

HIGH-GRADE, MODERATE IN PRICE

BARBER BROTHERS Cor. GRAPE and WATER Sts., Syracuse, New York

LAMB MARINE ENGINES



ALSO
EVERYTHING
FOR
BOATS and
ENGINES

GEO. H. TERRY CO.

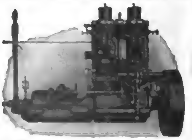
92 Chambers St., New York

The Mietz & Weiss Marine Oil Engines

OPERATED BY

Two Cycle Constant Thrust 1-120 H.P.

Kerosene Oil, Fuel Oil or Distillate



Simplest, Safest, Most Reliable and Most Economical Marine Engine on the market.

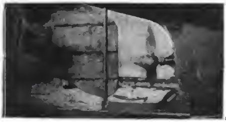
No Valves, Cams, Gears, or Electric Sparking Devices. No Vaporizers and No Dangerous Gasoline used.

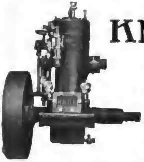
Marine 1 to 120 H. P., Stationary 1 to 150 H. P. Over 30,000 H. P. in operation.

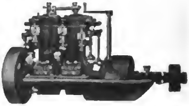
Catalogue upon request.

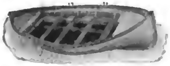
AUGUST MIETZ IRON FOUNDRY & MACHINE WORKS

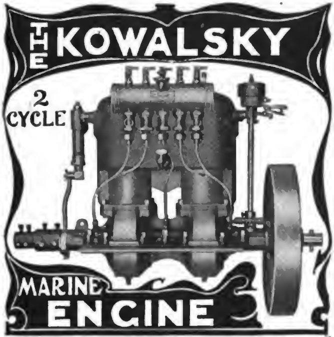
128-138 Mott Street, 87-89 Elizabeth Street New York, U. S. A.











KOWALSKY MARINE ENGINES

Represent the highest standards of workmanship, materials and designs. They offer the GREATEST possible amount of power and satisfactory service, accompanied by the LEAST possible trouble and expense.

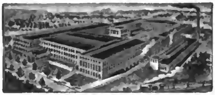
¶ We have purchased the Kowalsky Co. and have added their well known motors to our line. They are now being built at our own fully equipped plant.

WATERMAN MARINE MOTOR CO.

1500 WEST FORT STREET DETROIT, MICH.

COLUMBIAN ROPE CO.

Factory and General Office, AUBURN, N. Y.



MAKERS OF THE

"Columbian" and "Eureka" Brands Manila Rope, Ships' Hawsers, Hoisting Rope, Transmission Rope, &c.

NEW YORK OFFICE, 62 SOUTH STREET

ESTABLISHED 1816

WATERBURY COMPANY

MAKERS OF

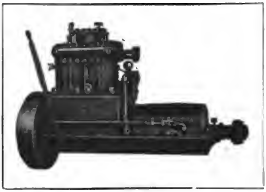
Manila, Sisal and Transmission Rope

WIRE ROPE

Also Rubber and Paper Insulated Electrical Wires and Cable

FACTORIES, BROOKLYN OFFICE, 69 SOUTH ST., N. Y.

HERE IT IS



The "Buffalo" New Slow Speed Heavy Duty Engine

Looks good, don't it?

An ideal engine for heavy work—heavy, strong, without vibration, reliable and durable

Cut shows 12 H. P. two cylinder, 6 x 7½. Other sizes and styles shown in 1907 catalogue—write for it

Buffalo Gasolene Motor Co.

1209-21 NIAGARA ST.

BUFFALO, N. Y.

Dying request of Admiral Lord Nelson :—"Hardy, do not throw me overboard. I desire to be buried beside my parents."

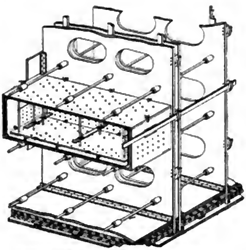
Anti Marine-Burial Assurance

SOME OF MANY REASONS WHY OCEAN PASSENGER STEAMSHIP LINES SHOULD EQUIP THEIR STEAMERS WITH A MORTUARY VAULT AND ISSUE ANTI MARINE-BURIAL ASSURANCE CONTRACTS TO THEIR PASSENGERS

First. It has long been a recognized fact that while the ocean going passenger steamers have, year by year, increased in size and magnificence until now they are of enormous tonnage, equipped with every appliance which science and skill can suggest for the safety, convenience and comfort of passengers, yet there is one feature of the ocean passenger ships which has been sadly neglected, or at least has not kept pace with the rapid advance of improvements in the service in general, and that is **the proper facilities for taking care of the bodies of passengers who are so unfortunate as to die at sea aboard such ships.** The present mode of disposing of the bodies of passengers dying at sea, is to either with scant ceremony drop them overboard, or in some unsatisfactory and makeshift manner (under favorable conditions) preserve and land them, in the latter instance with much trouble and annoyance to the steamship company, and at great expense to the family of the deceased.

Second. It fills up the only remaining hiatus in a strictly up-to-date ocean passenger steamer. Where money is lavished in the care and comfort of the passengers so long as they are living; while in event of death their bodies are given little, if any, better treatment than they would have received aboard a sailing packet of a hundred years ago.

Third. It will be a source of good revenue to the ocean passenger lines, amply justifying them in faithfully performing each and every provision of the Anti Marine-Burial Assurance contract.



Interior view of Mortuary Vault, showing one coffin in place

Fourth. The ocean traveling public desire this assurance and are willing to pay for it, especially as the cost is little (about the same amount as the usual "tip" to one's stateroom steward) and other conditions being anywhere near equal, will patronize lines whose steamers are equipped with a Mortuary Vault and issue Anti Marine-Burial Assurance contracts.

Fifth. The vaults are easy and cheap of installation, and there are absolutely no mechanical difficulties to be encountered in installing them.

Sixth. It is the best advertisement an ocean passenger line could have, for while there are a few people who profess not to care what becomes of their bodies after death, about 99 per cent. do care very much indeed, particularly objecting to their being thrown overboard as food for the monsters of the deep, and distinctly desiring a land burial. Where families composed of several members travel together, there is always a distinct (if latent) fear that some of the party might die and be dropped overboard.

Seventh. It will largely increase ocean travel, for a great many people (especially in the interior) and persons of nervous dispositions, who ardently desire to take an ocean voyage, also many in poor health, to whom such a voyage would be a boon, are deterred from gratifying their desire by that inherent dread of the possibility of dying aboard ship and their bodies being thrown overboard.

Eighth. There is every reason why the bodies of passengers dying aboard an up-to-date first-class ocean passenger steamer (which is a little world within itself) should be properly taken care of and no valid reason can be alleged why they should not be.

Ninth. The number of persons, realizing the risk of their bodies being thrown overboard in event of death, who insist on contracts with steamship authorities providing against such disposition before embarking on an ocean voyage; the distressing details of burial at sea of passengers (first-class and others) dying aboard en voyage; the large expense incurred by the family or friends of deceased in order to prevent such sea burials; the litigations growing out of such sea burials, when there was no one aboard ship authorized to order disposition of body, or pay the steamship company's charges for embalming the body aboard and landing it ashore, all point to the absolute necessity for the equipment of ocean passenger steamers with Mortuary Vaults and the issuance of Anti Marine-Burial Assurance contracts.

Memoranda:

The Mortuary Vault is of metallic airtight construction, situated in an always accessible part of the ship, equipped with perforated metal lined sanitary receiving coffins. As both the style of receiving coffin, and the construction of the Mortuary Vault (and their purpose) were generic the broadest claims were allowed on them by the Patent Offices of the United States and foreign governments.

The Anti Marine-Burial Assurance contract is covered by copyright in the United States and many foreign countries

W. S. UPSHUR, Patentee and Owner of Copyrights, Newport News, Va., U. S. A.

Reference:—SCHMELZ BROS., Bankers, Newport News, Va., U. S. A.

Copy of Anti Marine-Burial Assurance contract filled in for supposititious Steamship Line and Passenger:

FRONT.

Registered No. 501

Agency No. 101

Anti Marine-Burial Assurance

Blank Steamship Co.

Chicago, Aug. 25, 1907.

Dying request of Admiral Lord Nelson:—

"Hardy, do not throw me overboard. I desire to be buried beside my parents."

Mr. John Doe having paid the sum of $125.00 for a *first* class passage from *New York* to *Liverpool* per steamship *Louisiana* expected to sail *August* 28, 1907, and the further sum of $5.00 the *Blank* Steamship Company, will in event of the said *John Doe* dying ABOARD said steamship during said voyage, preserve his body aboard said steamship until arrival at the port of *Liverpool* where it will be embalmed, be placed in a hermetically sealed metallic casket and deposited in a Receiving Vault for the period of ten days, or such less time as may be necessary for the *Blank* Steamship Company to communicate with *Mrs. John Doe* of *Chicago, Ill.* and ascertain what disposition she desires to be made of the body, the *Blank* Steamship Company agreeing to (at the expiration of said ten days) either inter the body in an appropriate manner at *Liverpool* free of additional cost, or, at the request of *Mrs. John Doe* of *Chicago, Ill.* return it to *New York* for delivery to order of the said *Mrs. John Doe* on the pre-payment of $125.00.

BACK.

The *Blank* Steamship Company's obligation to retain and preserve the body aboard ship will become null and void for any of the following reasons, viz.:

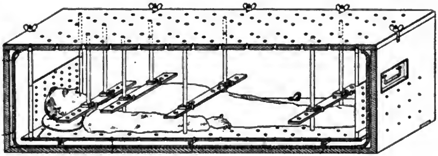
a. The assured dying of any contagious or infectious disease (the ship's doctor's decision in this regard to be final)
b. Ship being deterred from any cause whatever from reaching port of destination within a reasonable time.
c. Breaking down of ship's refrigerating plant or other preservative appliance.
d. The repository of the body being so injured by fire, or from any other cause, as to destroy or seriously impair its preservative features.

President.

Secretary.

In accepting this agreement, I acquiesce in all the foregoing provisions and conditions and in event of my death during this voyage, I desire the *Blank* Steamship Company to notify *Mrs. John Doe* of 2501 *Chestnut Avenue, Chicago,* and accept her instructions as to the disposition of my body under this agreement.

Signature of Assured.



Showing manner of securing body in receiving coffin

United States patents issued July 2nd, 1907

British patent issued (as of) January 21st, 1907 **French, German and other European patents applied for**

Copyrights secured in United States, Great Britain, France, Germany, Italy and Holland

This form of Anti Marine-Burial Assurance is most highly commended by the Marine Journals and Newspapers of America, as also by many Americans of international repute, notably among whom are—His Eminence, James Cardinal Gibbons and Rt. Rev. Henry C. Potter, Bishop of New York.

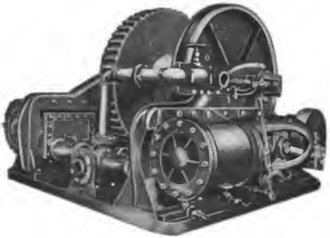
OPERATING RIGHTS FOR SALE

Full specifications and working drawings furnished on application

Correspondence with Managing Directors of Ocean Passenger Steamship Lines solicited

ADDRESS ALL COMMUNICATIONS TO

W. S. UPSHUR, Newport News, Va., U. S. A.



HELLO, CENTRAL! give me NUMBER 23

HELLO, is this the HARD-UP TOWING CO.? Yes. Is the manager there? Yes, you're talking with him.

Well, Mr. Manager, this is captain PROGRESSIVE of the tug GET WISE. We have just parted our TOWLINE again, and must have a new one.

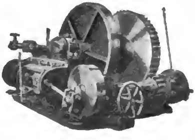
Confound it! Captain, seems to me you are always parting your hawsers, and I am sick and tired of paying out good money for hawsers.

Well, Mr. Manager, you're right, these manila hawsers don't last long enough to pay for buying them. SAY, WHY DON'T YOU TRY A STEEL HAWSER THIS TIME?

It will cost you less than the manila, and, besides, it will last about as long as six or eight manila hawsers. I know this to be so, for I have friends who are using them every day.

You talk like a "land lubber," Captain. How, under heaven, can you handle and stow a steel hawser on a boat?

"Land lubber," nothing, Mr. Manager. Why! it's as easy as falling overboard, if you use an Automatic Towing Machine, such as I run up against every day.



"Will neither leak nor lock"

GLAZIER UNIVERSAL NOZZLE

FOR MARINE USE

This is a flexible nozzle for stationary pipe or hose connections.
Can be turned in any direction and will remain in position without attendance.
Has other attractive features.
Write for catalogue and prices.

SOLE LICENSEES

S. F. HAYWARD & CO.

ESTABLISHED 1868

20 WARREN STREET — NEW YORK

Anything and Everything for Fire Protection

Eureka Fire Hose

Awarded Gold Medal at the St. Louis Exposition for Superiority of Our Goods.

TRADE-MARK

SAFEST AND BEST

FULLY TESTED AND MADE TO LAST

"A word to the Wise is Sufficient"

Seamless Woven and Rubber-Lined

EUREKA FIRE HOSE

"PARAGON" BRAND Has No Equal

SEND FOR SAMPLE

EUREKA FIRE HOSE CO.

13 BARCLAY STREET, NEW YORK

BALDT STOCKLESS ANCHOR

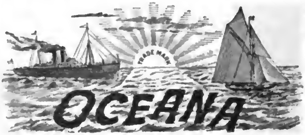
Made of the finest quality of open hearth steel, better than forgings.

Used extensively by the United States Navy on their battleships and cruisers.

Send for Catalogue

BALDT ANCHOR CO., CHESTE

The Spar Varnish that lasts



MARINE SPAR

resists the destructive action of moisture, salt or fresh water, etc., BETTER than any other make of Spar Varnish in the market.

It works freely, dries hard and is exceedingly durable. Particulars and Proof on application.

Standard Varnish Works

THE LARGEST VARNISH WORKS IN THE WORLD

29 Broadway, NEW YORK — 2620 Armour Ave. CHICAGO

LONDON — BERLIN — BRUSSELS

CANADIAN BRANCH

INTERNATIONAL VARNISH CO., Ltd., TORONTO

The BRAENDER BILGE SYPHON "Always on Watch."

The BRAENDER AUTOMATIC BILGE SYPHON

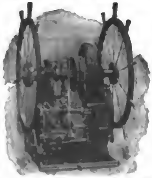
when once set in place, will, without any care or attention, do its work with intelligence and promptness, as it does not waste steam when not in operation, and begins to work upon the least accumulation of water in the hold. It is simple in construction, automatic in its nature, not liable to get out of order, made of the best Steam metal, and is guaranteed to keep the hold of a vessel properly dry, and do all that is claimed for it.

This automatic device has received commendation from all leading engineers throughout the country. Its simplicity of construction, durability, and entire freedom from possible disarrangement, together with its pronounced success in removing large quantities of water at a nominal cost of operation, has won for it the approval of ship-owners and seamen everywhere. With all these advantages, its moderate cost places it within the reach of every one. By giving the BRAENDER BILGE SYPHON a trial you will be convinced that it does everything we claim for it.

PHILIP BRAENDER

143 West 125th Street, New York

The Dake Pilot House Steam Steerer



A Simple, Compact and Durable Machine

Occupies Small Floor Space

Write for descriptive circulars and prices

THE DAKE ENGINE CO.

GRAND HAVEN, MICH.

New York Office, 120 Liberty St.

When writing to advertisers, please mention INTERNATIONAL MARINE ENGINEERING.

HIGHER SPEED with LESS COAL

FORCED DRAFT
MULTIPLE EXPANSION
HOT FEED WATER

Will save a LITTLE power

A STANDARD
ROLLER PROPELLER
THRUST BEARING

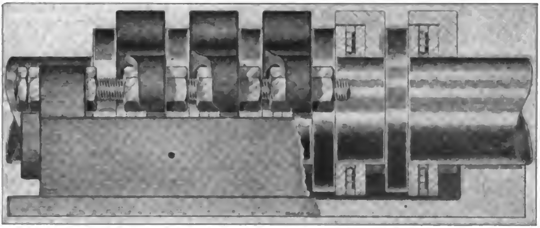
Will save you MORE

We have a splendid thing. Investigate it. You split hairs on indicated horse power; you save power by forced draught, multiple expansion, etc., and WHERE DOES IT GO? Is it eaten up by FRICTION in an antiquated Babbitted Thrust Bearing?

WHY DON'T YOU SAVE THIS LOSS? We guarantee a STANDARD ROLLER BEARING to increase your speed and save your coal. It delivers the power AT THE PROPELLER.

CAN YOU AFFORD to be behind the times? To keep on wasting your coal and speed in needless friction?

THINK IT OVER.

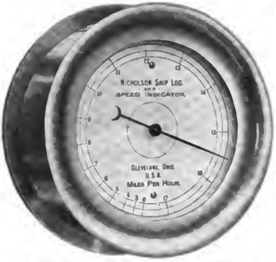


LIST OF SHIPS FITTED, RESULTS SECURED, OR ANY FURTHER INFORMATION WILL BE SENT BY

These Roller Bearings are used in all modern engineering. Try them on the Rudder Post and Windlass and note the difference. They turn Friction into Speed and Time into Money.

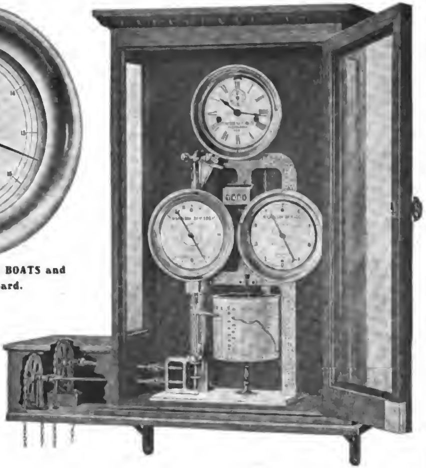
STEPHEN P. M. TASKER,
Marine Engineer,
PENNSYLVANIA BUILDING,
PHILADELPHIA, PA.

(S. S. "Aphrodite" of 3300 I. H. P., with a Roller Thrust steamed 50,000 miles with a saving of from 4 to 5 tons of coal per day and no wear or trouble.)



SPEED INDICATOR for MOTOR BOATS and YACHTS of low freeboard.

The hand points to the speed the boat is making through the water at the time of observation. Every variation of speed will instantly be shown on the dial. The same principle is used in installing on Motor Boats as on large Steam Ships.



The Nicholson Ship Log and Speed Indicator

has proved its superiority over all other logs. It is the only log that shows the speed per hour on a dial, records every variation of speed on a chart and counts the miles traveled. It is the only log operated without a line and rotator.

What Masters say who use the Nicholson Log:

"After three years use of the Nicholson Log I can cheerfully state that it is invaluable, its extreme accuracy makes it an instrument I should not want to go to sea without."

"A year's exhaustive trial has convinced me that the Nicholson Log is by far the best speed registering device yet produced."

"The chronograph attachment provides a graphic and continuous record of the speed performance of the ship, which can be filed away for future reference. It would furnish incontestable evidence in case of accident or controversy."

"Just as the ship's course is shown at any moment by the compass, so is its speed shown at any moment by the Nicholson Log."

Send for Catalogue

NICHOLSON SHIP LOG CO., Cleveland, Ohio, U. S. A.

Eastern Agents—BARRETT & LAWRENCE, 662 Bullitt Building, Philadelphia, Pa.
Pacific Coast Agents—C. P. NICHOLSON, 82 Market Street, San Francisco, Cal.

FIG. 103
Folding Lavatory, mahogany or oak case, nickel-plated interior, with self-closing faucet. For overhead or pressure supply.

FIG. 23
1¼-In. Nickel-plated Brass, Double Acting Pump. To screw against bulkhead for lavatories, etc.

FIG. 101
Folding Lavatory, oak or mahogany case, porcelain bowl, nickel-plated interior, with self-closing faucet. For overhead or pressure supply.

FIG. 401
Ventilator with Deck Plate Glass or Solid Plug.

FIG. 112
N. P. Copper Lavatory, 15 in. on back. N. P. copper water bottle, support and waste pipe. Waste receiver of copper, painted white enamel.

FIG. 13
Bilge Pump, composition valves and cap. Length of chamber over all 21 in. Shorter if desired.

FIG. 25
All-brass Galley Pump, 1¼-in. cylinder, with handle which may be swung to any angle.

If interested in any of the above, or anything that pertains to Marine Sanitary Goods, we will gladly advance any information you may need

A. B. Sands & Son Co.

22-24 Vesey St., New York

Let Us Hear From You

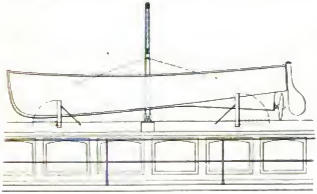
FIG. 100
Folding Lavatory, mahogany or oak case, porcelain bowl, N. P. interior and pump, soap cup, brush holder, towel rack, and trimmings. Height 20 in.; width 19 in.

ENGINEERING SPECIALTIES SUPPLEMENT

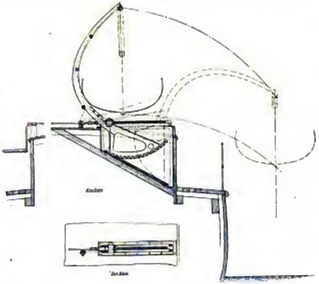
Information concerning some of the useful devices used in various capacities in shipyards and repair shops, and aboard ship.

The Welin Quadrant Davit.

We have previously made our readers acquainted with the characteristics and advantages of this system of boat launching gear. As a further illustration of the adaptability to the various modes of carrying boats on vessels of different types, we now give a diagram of the "M" style. This type has been



specially designed for use on good sized motor yachts, where it is the practice to carry a tender or rowing boat on the top of the trunk cabin. Ordinary davits are in such cases more or less unsatisfactory, as it is impracticable to give them a sufficient amount of overhang to lift the boat outboard, from its position in the chocks, to clear the side of the vessel. Moreover, such davits become unnecessarily heavy, and are difficult to handle if the vessel has the slightest rolling motion.



With a single davit of the type here illustrated, one man can, with perfect safety to the boat, swing it out across the deck clear of the rail in about thirty seconds. The davit head stands less than 5 feet above the crown of the cabin's roof. The frame, serving as a guide for the quadrant, projects a little inside the cabin, but only to a very small extent. When placed against a bulkhead this even is hardly noticeable. The frame has been provided with a casing of thin brass plate, to prevent any possible leakage. The whole apparatus is made of toughest manganese bronze, and can be had either plain or polished, in accordance with the purchaser's desire. It is placed on the market by Capt. A. P. Lundin, 17 Battery Place, New York.

A New Crane Pipe Machine.

This machine is one of the latest models, and embodies the most modern improvements in the manufacture of pipe cutting and threading machines. It is very substantially and compactly built, consisting practically of but three pieces. All working parts are so placed that strains come directly on top of the base. The motor is located on top of the machine, directly over the bed, where it can be best taken care of, be out of the operator's way and protected from chips. Of the quick-grip and sliding die head type, the machine was designed for use where rapid production is essential.

The gripping chuck is of a specially constructed type, so designed that any pipe may be either gripped or released by

moving a lever, without stopping the machine. It contains four jaws made of high grade steel, with eight removable roller contact teeth, which will grip (without slipping) pipe that is not perfectly round. These jaws are adjusted by an internal cam operated by a worm and gear. The rear end of the spindle contains an independent three-jaw chuck, used for centering or gripping long lengths of pipe. To facilitate the operation, removable bushings are supplied to fit in the spindle to guide pipe through the gripping chuck.

The die head is movable, and carries with it adjustable expanding dies in sets of six, pipe-centering guides, and patented air cutting-off attachment, operated by an air pressure device controlled by an air cock. The opening and closing of this cock governs the working of the two cutting-off tools. This is said to be the most efficient and satisfactory means yet invented for cutting off pipe. The dies are of high-speed steel, made extra long, and will cut threads for extra heavy flanges of fittings, and still maintain the exact taper on the threads. For threading pipe below 4-inch an extension die head is supplied, which should always be used, as it supports the dies and prevents them from bending. The dies may be removed from the head by taking off the cover, which immediately exposes all the dies.

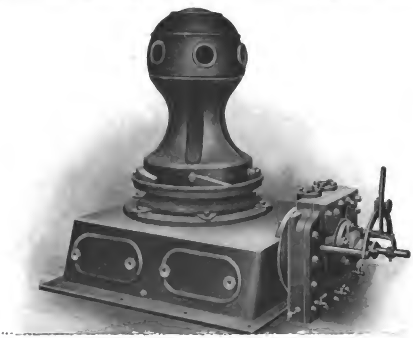
A rotary oil pump is supplied, and particular attention has

been given to the distribution of oil on the dies. The belted machine contains a three-step cone pulley, which, with back gears, gives sufficient change of speed for all sizes of pipe within the range of the machine. These machines are furnished for engine, belt or motor drive, the capacity being pipe from 2½ to 6 inches.

Dimensions: Countershaft pulley, 20 inches diameter by 6-inch face; countershaft speed, 125 revolutions per minute; weight, 9,000 pounds; floor space, 9 feet 6 inches by 4 feet 6 inches.

The Dake Steam Deck Capstan.

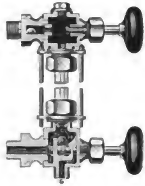
The Dake Engine Company, of Grand Haven, Mich., has brought out a new capstan which is extremely simple in construction, and is said to be unequaled for ease in handling and power, as well as compactness. It has no dead center, and is made for two pulling speeds, regulated by the throw of the reversing lever. The working parts being entirely inclosed overcomes all danger from dust or dirt. It can be simply placed on the deck and bolted down, steam and exhaust pipes connected and it is ready to work. They make only one size, fitted with an engine of 10 horsepower. The distance from deck to center of capstan head is 28 inches; size of steam pipe, 1¼ inches; size of exhaust pipe, 1½ inches; over-all dimensions of bed, 42½ by 45 inches.



An Automatic Water Gage.

Herewith we print a cut of what has the reputation of being a high-class automatic water gage. The "Success" has many good points several of which are of vital importance to users of water gages. For instance, its automatic devices will not stick or become corroded. The automatic balls must go to seat when glass breaks. Blow-off is operated by gage handle and seats of valve can be reground. The objections to many automatic gages are that the automatic devices go to their seats on the sudden opening or closing of blow-off, or they become corroded, stick fast and do not operate at the critical moment. An examination of the "Success" gage will convince any engineer that these two objections are entirely overcome, as will be seen from the following explanation:

E is a double-seated valve to close both the gage and the blow-off. It will be seen, therefore, that every time the lower handle is turned to blow off the gage, the automatic device or ball *D* is moved by the stem on which it rests. In addition to this, the stem follows the course of the arrows *B* to the outlet *G*, creating a downward pressure on the ball *D*, and rolling it about in the chamber in which it is located. This great agitation of this ball from three to six times a day prevents it from ever becoming limed up and stuck fast. When the glass breaks, everything is reversed; the steam rushes upward to the break, creating a strong vacuum at the lower end of glass, when ball *D* is instantaneously raised to the location marked *C*, when flow of steam ceases. The upper ball is forced to its seat by pressure from boiler. The double seats of valve *E* can be ground by simply loosening the stuffing nut on handle.

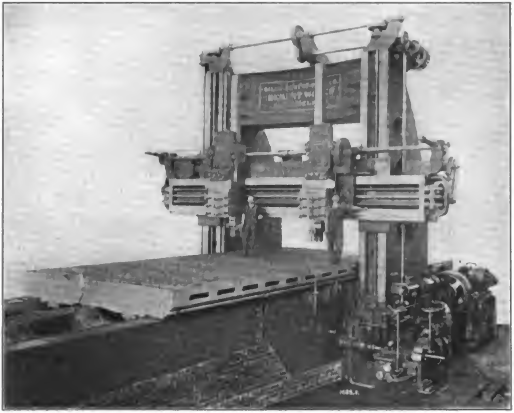


The Penberthy Injector Company, of Detroit, Mich., manufactures the "Success."

A Gigantic Planer.

Probably the largest and heaviest metal working planer ever built has recently been shipped from the Bement-Niles works (Philadelphia) of the Niles-Bement-Pond Company. The total weight of the machine is 845,000 pounds, or 422½ short tons. Four motors with a total capacity of 207½ horsepower are required to operate this remarkable tool.

The machine is, in general effect, an extremely large planer, but in addition to the movements found on a standard machine, many new ones have been added. Each head is fitted with a slotter bar, independently driven by rack, giving a cutting speed that is practically constant from one end of the stroke to the other, and a quick return. Through motor and change gears the cutting and return speeds can be changed as desired. Each head is arranged for transverse planing, having a planing movement across the bed which can be varied within desired limits, and having a quick return. The movements for slotting and transverse planing make it necessary to throw out the regular driving mechanism to the table and connect it to a separate feed motion, which, in this case, is entirely distinct from the regular feed motion. This throwing out of the driving mechanism, however, means simply that the

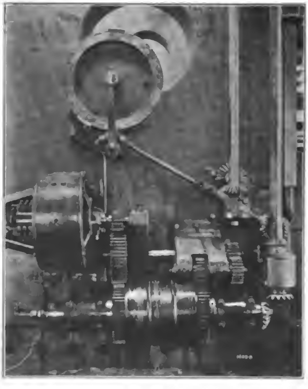


pneumatic driving clutches are thrown into and left in their idle position.

The machine is fitted with its own air compressor and motor, thus making it independent of the air supply in the shop, to which, however, it can be connected if it seems desirable. A complete switchboard is furnished for control of all the motors.

The distance between uprights is 14 feet 4 inches; the maximum distance from table to bottom of cross slide is 12 feet 2 inches; maximum stroke of table is 30 feet; maximum stroke of slotter bar is 8 feet; total width of bed 13 feet; length of bed 60 feet; table ways 15 inches each in width; tool slides 7 feet 8 inches, with 4 feet vertical traverse; cross rail is long enough to admit full traverse of either head between the posts; face of uprights 2 feet 6 inches; vertical height of cross slide, including the top rib bracing, is 5 feet.

The main driving motor is 100 horsepower; slotting and



cross-planing motor is 50 horsepower; lifting motor to cross slide 20 horsepower; traverse motor for heads on cross slide 7½ horsepower; air compressor motor 30 horsepower. The cutting and return speeds are variable through the motor, which has a 1 to 1¼ variation and further range by change gears. The cutting speeds are 14 to 25 feet and return speeds 52½ to 65½ feet per minute. The same style of drive is used for the slotter, and gives a cutting speed of 18½ to 30 feet, and return speed of 57 to 71 feet. Cutting speed for cross planing is 11½ to 19 feet, and return speed 35 to 43½ feet. The cross traverse speed to the heads is 50 inches per minute; the vertical speed for raising and lowering cross slide is 26 inches per minute.

The main drive from the 100-horsepower motor is through the gearing to the pneumatic reversing clutches at the base of the upright. The speed of these clutches can be varied to some extent by changing the speed of the motor, and a great variation obtained by the simple reversal of two change gears. The pneumatic clutches are of the N-B-P type, with a large number of friction disks, whereby great friction area is obtained in a comparatively small compass. These clutches, as their name implies, are operated by compressed air. A small valve, easily moved by hand, controls the stopping, starting and reversal of table, and handles satisfactorily the power given out by the large driving motor. In the handling of this amount of power in a motor-driven planer, it is unnecessary to state that it would be quite impracticable if a belt-drive were employed. From this point on to the rack the drive is, in practically every respect, that which is found on any planer, except that in this instance it is exceptionally heavy and powerful.

Among the many other new features, not the least is the pneumatic feed for the cross heads. On the side of the upright, just above the gearing, is a cylinder with piston rod extending to the left. This rod carries a rack which meshes into a gear near the bottom of the vertical feed shaft. This shaft has, on its lower end, a bevel gear meshing into another bevel gear on a horizontal shaft, which transmits motion to the vertical feed shaft on the left-hand upright. The movement of these feed shafts is constant at all times, and variation in amount and direction of head feeds is obtained by adjusting the connecting rod in the slotted cranks on the ends of the cross-slide. These cranks are graduated in such a way that definite cross and vertical feeds can be obtained, and by using at the same time the cranks on both sides, an angular feed can be given to the tool, which is at times desirable, as the whole heads were not designed to swivel. The valve for controlling the air to the feed cylinder is thrown automatically at each end of the stroke, this movement being taken from either the main driving gear train to the table or the slotting gearing when slotting is being done. To throw out the feed it is simply necessary to close a valve, cutting off the air supply.

Owing to the great weight and large dimensions, it was impracticable, both from the manufacturing and the shipping standpoint, to make the bed or table in one piece. They were, therefore, divided to bring them within reasonable limits. The central section of the bed is divided longitudinally into three parts, and the two end sections into two parts each, or seven parts in all. The total weight of the bed is about 275,000 pounds. The table is made in two sections, divided longitudinally in the center, and weighs about 140,000 pounds.



THE POLISHING ROOM—DELAWARE MARINE SUPPLY MANUFACTURING COMPANY—THE ASSEMBLING ROOM.

The Delaware Marine Supply Manufacturing Company.

This company was established in March, 1902, and commenced business in October of the same year, in Wilmington, Del., in a very modest way; but the demand for goods has kept increasing, so that in the course of its five years of existence its capacity has grown to about five times its original size. While this, in itself, indicates a healthy growth, it has to be further noted that the line of manufacturing here undertaken is one which requires great skill in execution, for the reason that a high grade finished article has to be produced at a marketable price with a profit, therefore necessarily requiring a low factory cost, which can be accomplished only by specially designed labor-saving tools, a pointed system, well trained working force and factory economy. The line of goods is of a varied nature and includes ship airports in all designs, cast brass and bronze hinges, screw work, ship and boat fittings; car hardwares, such as parcel racks, sockets, catches, etc., and general marine hardware; all these articles being manufactured in cast brass or bronze from the ingot to the finished product.

The work is distributed through the shop in classified manner, so that each group of workmen is trained for one of these classes, and perfection is obtained through subsequent handling of the same kind of work. Most of the work is done on the piece-work plan, and a rigid inspection through

THE MACHINE SHOP.

all the stages of completion prevents the slighting of the work. No secrecy is kept as to the ruling wages, the best producer receiving the highest pay and most consideration; and promotion to higher positions is done as much as possible among the most deserving of the old hands.

The plant consists of the following departments: (1) Brass foundry and cleaning room; (2) machine shop; (3) polishing shop; (4) plating shop; (5) lacquering shop; (6) assembling shop. Besides this there are a drafting department, pattern shop and a well-equipped tool shop, where all special tools are made. A storeroom and stockroom also furnishes part of the equipment.

The laying out of the plant is so adjusted that the different departments adjoin each other in such a manner that the least time is lost in handling and transportation. This is a very important factor, especially for the hardware line, as these articles have to undergo a great many operations before completion. Thus, a small piece of hardware has to travel through foundry to cleaning room, dipping room to storeroom, where inspection of castings are made; from there it is passed to machine shop, polishing room, lacquering room, assembly room, and then finally to packing room, where the last inspection and packing are done.

New High-Speed Motor Boats.

The Electric Launch Company, of Bayonne, N. J., has just shipped two high speed *Elco* express boats to G. & O. Braniff & Co., of Viguetas de Acero Belga, Mexico. The photograph illustrates one of the boats, which were 40 feet in length, 5 feet 6 inches beam, and 2 feet draft. Hulls are of substantial, but light, construction, oak frame, cedar planking, copper fastened throughout. Decks and interior are handsomely finished in mahogany. The power equipment consists of a four-cylinder 6 by 6-inch gasoline marine engine with mechanical reversing gear, Tobin bronze propeller shaft and bronze propeller wheel. The builders guaranteed a speed of 19 miles an hour, which in each boat was exceeded, the tests being carried out during very rough weather on New York bay over a measured mile course, an average of six runs being taken. The *Chapala*, one of the boats, exceeded a speed of 19.6 miles per hour.

The motor is located forward of the operator's cockpit under a metal hood, with control reverse brought out on

bulkhead alongside of steering wheel. The fittings and furnishings of the boat are very complete, including cushions, wicker chairs, cape-cart folding automobile hood, acetylene searchlight, glass wind shield, etc.

These boats closely resemble other types of *Elco* express boats, of which the company has made a specialty during the past few years, and which have proved very successful in the hands of their customers. The boats are not racing machines, but serviceable high-speed pleasure boats which, it is claimed, will serve one on water as the automobile does on land.

INTERIOR OF THE JERSEY CITY SHOP OF THE GRISCOM-SPENCER COMPANY.

The Griscom-Spencer Company.

The Griscom-Spencer Company is the direct successor of the old James Reilly Repair & Supply Company, established some forty years ago, and which for many years provided all the repairs and supplies for the ships of the International Navigation Company (American and Red Star lines). Their New York shops and pier in Jersey City, adjoining the terminal of the Pennsylvania Railroad, have recently been rebuilt and equipped with all modern facilities for handling steamship repairs and installations with the greatest economy and efficiency. Their location is especially convenient, being just opposite the lower end of Manhattan Island, and close to all the principal ferries. Being so centrally situated, repair gangs are sent readily and quickly to any vessel requiring their services, wherever she may be lying in New York harbor.

EXTERIOR VIEW OF THE JERSEY CITY REPAIR SHOPS.

GENERAL VIEW OF THE WHARFAGE AT JERSEY CITY, SHOWING NUMEROUS VESSELS UNDER REPAIR.

The Philadelphia shops, at the foot of Washington avenue, are equally convenient to vessels lying in the Delaware river.

In the matter of ship supplies, the company is probably the largest in the United States, and is the only concern equipped to do both a repair and supply business on so large a scale.

The Jersey City yard, which we illustrated at page 403 in October, 1906, has two Pennsylvania Railroad switches, one at Grand street and one at Sussex street, making it convenient to load and unload machinery and supplies. A small industrial track runs all around the building to facilitate the handling of heavy material. Duplicate air compressors are installed and air and water pipes conducted down to the end of the mooring pier.

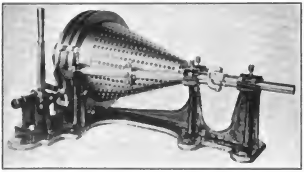
The supply building on West street is one of the most modern structures of the kind in the city of New York. It has been especially built and equipped for the purpose of conducting a ship chandlery, hardware and contractors' supply business. It is six stories high, with inside measurement of 50 by 110 feet, and has two electric elevators. The general offices are in the new West street building, New York.

The R-W Speed Variator.

This device, placed on the market by the R-W Speed Variator Company, Singer building, New York, for deriving variable speeds from a constant-speed motor, differs in a number of important respects from all prior devices for a similar purpose, and by virtue of its novel features the device is said to possess marked durability, efficiency, simplicity and ease of control. Fundamentally, the device is based on the gear-and-cone principle, but utilizes this principle in a new and strikingly ingenious way. It is especially applicable to motor boats.

As will be seen in the figure, the gear cone is provided with a number of circumferential rows of gear pits, and parallel with the slant of the cone is a shaft on which is feathered a spur gear having pin teeth of a general conoidal form. This gear is adjustable longitudinally on its shaft, so as to be brought into mesh with any desired row of gear pits on the cone, thereby causing the driven element, which, of course, may be either the gear or the cone, to rotate at a corresponding speed.

From mathematical considerations, deducible from the geometric properties of a cone, if the number of pits in the successive rows differs in arithmetical progression, the rows themselves must be equidistant from each other. Hence the



gear can be shifted by equal steps from either end of the cone to the other and be in mesh with a row of pits at each and every step. Furthermore, the rows can be so arranged that one pit of each row will lie in (or, strictly speaking, will be bisected by) the same axial plane. Stated otherwise, this means that the circular rows can be arranged so that one pit of each row will be exactly in line with the correspondingly located pits on all the other rows. This straight or longitudinal series of pits is formed on a sliding bar capable of movement in both directions a distance equal to the space between successive circular rows of pits. It will thus be seen that if, at the instant in the cone's rotation when the

slide is parallel with the gear shaft, the slide is shifted, it will carry the gear to the next row of pits.

At the base of the cone are two grooves, which the slide crosses, and projecting from the slide into the grooves are two studs, the arrangement and proportioning of the parts being such that the studs, when the slide is in its normal position, are spaced slightly from the rib between the grooves. Adjacent to the grooves are two oppositely inclined cams, each equal in width to the distance which the slide must move to transfer the gear from one row of pits to the next, so that the cams, engaging the stud on the slide, will shift the slide the proper distance. The cams are mounted on the upper ends of two arms pivoted at their lower ends. For the purpose of actuating the arms they are connected by links to a controlling lever on opposite sides of the pivot of the latter. This method of connecting the cam-arms with the controller makes it impossible to throw both cams into the grooves at once.

To restore the slide to its normal position after each actuation, an inclined member is provided at each side of the flanges at the base of the cone, against one or the other of which one of the slide lugs strikes after passing the gear. Thus if the slide has been moved toward the base of the cone, the end of the slide projecting beyond the flange will engage the adjacent inclined member and will thereby be thrown to the normal position. It will be seen that as long as one of the cams is held in its grooves, each revolution of the cone will produce an actuation of the slide and a corresponding shifting of the gear, so that the latter will move step by step up or down the cone, according to which cam is in operation. Arriving at the end of its shaft, the gear can, of course, go no further in that direction, and the cam must be retracted before the succeeding revolution of the cone brings the slide again into position for actuation. This retraction of the cam is effected automatically by mechanism inside the cone, which acts to throw the cam out of its groove, against the force exerted by the operator, just before the slide-lugs reach the position of the cam.

Mills Engaging and Disengaging Gear.

Of the many engaging and disengaging gears which have of late been placed on the market, the Mills may be safely said to have well proved itself. The reason of this is chiefly its simplicity and reliability in all kinds of weather and conditions, not only in regard to the detaching, but also to the attaching of the boat, which operation is often found quite difficult in a heavy seaway. This gear is especially sure and safe in the hooking on, and absolutely cannot jam the hands or fingers of the men, for the reason that an eye instead of a hook is used, and the block is handled entirely from the opposite end to the eye—in fact, the weight of the block alone hooks it on, with no danger to the operator.

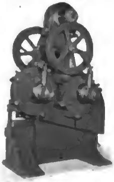
It has, in the last four or five years, been subjected to the severest tests, and is at present used by about two hundred and fifty steamship lines, plying to all parts of the world. It is also extensively used in cable ships and pilot boats. Most seafaring people know that the two last mentioned have much more real boat work in the open seas, under all weather conditions, than any other service. The only drawback of the gear, with regard to its adaptability to the average lifeboat carried on American passenger vessels, is that it costs somewhat more to install in old life boats than some of the other hooks on the market. Yet all those who have so far made use of this gear in such instances have expressed themselves as well repaid for the extra outlay, feeling they have made use of the best possible appliance.

When building new lifeboats it can be installed as easily and as economically as any other, and therefore it would be worth while for ship owners and boat builders to consider the adoption of this apparatus when laying down the plans of the lifeboats. It is handled by Capt. A. P. Lundin, 17 Battery Place, New York.

Universal Angle and Plate Shear.

The illustration represents a new universal plate splitting shear manufactured by A. F. Bartlett & Company, Saginaw, Mich., for cutting plates, bars and angles of even and uneven legs, also small channels, by making extra shear-knives. The designer has found this shear a valuable tool for all boiler makers and metal workers.

The square opening on the side is the angle shear, which cuts angles of even and uneven legs to any angle up to 45 degrees. Both shears are driven from one pulley, the angle shear running in a 45-degree angle, and can be operated singly or both at one time. The clutch stops only at highest point. The clutch lever is universal, and can be turned to any side, to suit the operator. Cutting uneven legs of angle iron has always been difficult to accomplish, and necessitated large, special machines for the work, which were too costly for small manufacturers. This universal combination shear embodies all the best features of the double angle-iron shears, besides being a plate and bar shear which can readily be changed into a



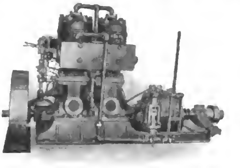
punch. It has proved a great labor-saving tool. Bars can be cut on either shear, and an extra shear for small channels can be inserted on either side. The machine has been designed to save floor space, and is very strongly geared.

A Two-Cycle Marine Engine.

The Termaat & Monahan marine engines, built in Oshkosh, Wis., are all of the two-port, two-cycle type, and are designed to eliminate the reversing propeller and reverse clutch. Four years' experience have demonstrated that the reversible engine is thoroughly practicable, and considerably more simple than any system of reversing gears. The Termaat & Monahan engines of double cylinder and above are started in either direction by the spark, or reversed while in motion; no cranks for starting are furnished, therefore danger of personal accident

is avoided. The fly-wheel rim is turned smooth in the form of a hand-wheel, so the engine can be turned around slowly when desired by the rim of the wheel. Friction clutches can be furnished for throwing off the load for starting or reversing, or a reversing clutch can be attached.

All of the Termaat & Monahan engines are said to give a good margin in power and are not overrated, the cylinders are large for the rated power, the crank shafts are extra heavy and the bearings are long. The oiling system is a point that must not be overlooked; oil is led to all bearings, the crank pins receiving oil as positively as other parts through oil

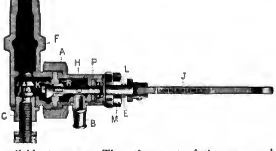


rings secured to the sides of the cranks, in which the oil drops and is carried through the crank pin to the bearing, which is all important for long and continuous service. The exhaust outlets are large, and provide for quick expulsion of the burnt products, so that no back pressure is produced at high speed, and under-water exhaust can be used with beneficial results.

The Termaat & Monahan 8-horsepower engine is used in launches from 20 to 24 feet, and the 12-horsepower in 22 and 32-foot launches, showing speeds of from 11 to 14 miles per hour. These are the two popular sizes at the present time, and are double-cylinder self-starting and reversing. Termaat & Monahan speed propellers are used on all Termaat & Monahan engines. These propellers are of very fast model, and in some cases show only 7 percent slippage. The Termaat & Monahan engines are arranged to use kerosene where gasoline is not obtainable.

An Improved Gage Cock.

The gage cock shown herewith is known by the trade name of "Excelsior," and is manufactured by the Lunkenheimer Company, Cincinnati, Ohio. The cock is made in two parts, held together by the union ring *A*. That part to which the lever *J* is attached contains the operating mechanism and parts



most liable to wear. The other part of the gage cock is screwed into the water column, and contains an emergency valve, which is easily opened or closed by means of a wrench applied to the nut *D*. The object of this emergency valve is to make it possible to remove the part containing the operating mechanism, while pressure is on. It will, therefore, be seen that, should accident happen to the cock, or should it be found necessary to clean the same while pressure is on, it can readily be accomplished by simply closing the valve *D*.

Another important feature in the construction of the gage cock is the renewable, reversible seat *R*, which aids in making a very durable construction. The lever *J* is adjustable, and can be turned to any desired position. A rope or chain can be attached to it should the same be beyond reach from the floor. The spring *M* will last indefinitely, owing to the fact that there is no possibility of its becoming limed up, or losing its tension. This is due to the fact that it is not in the least exposed to the escaping steam or water.

Corrosion of Marine Boilers.

Many and various have been the explanations offered for the phenomena of internal corrosion in marine boilers, and perhaps the present article may help to throw some light upon the subject by presenting the now generally accepted facts in brief form, and untangling some of the confusion arising from the multitude of conflicting statements and observations. Professor Vivian B. Lewes—a recognized authority on the subject of marine boiler deterioration—states that in the presence of moisture, carbonic acid and oxygen simultaneously attack iron and steel, forming a thin layer of carbonate of iron. This is a very unstable salt, which almost immediately breaks down into iron oxide and ferric hydrate, liberating the carbonic acid, which, with a further supply of atmospheric oxygen, continues the process of corrosion or rusting. This process is further hastened by a certain degree of electrolytic activity between the iron and the electro-negative hydrated iron oxide. Inasmuch as the layer of oxide or, as we commonly know it, rust, is highly porous, the action progresses without interruption as long as the conditions are favorable. The above general conditions obtain when any iron or steel is exposed to the action of oxygen, carbonic acid and moisture.

Internal corrosion is due chiefly to the presence in the feed water of some oxidizing agent such as air, carbonic acid gas, free acids or dissolved salts which have the property of eating iron and steel. Often the internal corrosion is the result of the presence of free fatty acids liberated by the decomposition of greases or oils, containing animal or vegetable fats, or oils introduced by lubrication and brought into circulation by the surface condensers now in general use. The rational remedy for this effect is to use no lubricants for steam-swept surfaces except pure mineral oils, which cannot decompose into acids.

Perhaps the most common cause of internal corrosion is the dissociation of magnesium chloride (of which common sea water contains about 245 grains to the gallon) into hydrochloric acid and magnesia. The acid attacks the iron with great rapidity, forming a chloride of iron, which, as soon as formed, is dissociated in its turn by the free magnesia, producing oxide of iron (plain rust, black or red) and hiding its own action by reverting to chloride of magnesium—the salt which started the trouble. It appears, therefore, that no hope may be found for this trouble in the exhaustion of the injurious reagent by the formation of insoluble salts, but that on the contrary the corrosion must continue indefinitely, unless specific means are employed to neutralize the acid elements or link them with other mineral bases for which they have a stronger affinity than for iron. If, therefore, carbonate of lime is introduced into a boiler, its carbonic acid will unite with the magnesium base of magnesium chloride, forming the highly insoluble magnesium carbonate, while the hydrochloric acid of magnesium chloride combines with the lime base and forms highly stable and perfectly harmless chloride of lime. It is perhaps not amiss to add for those

readers who are not familiar with chemistry that the chloride of lime above referred to is not the "chloride of lime" of general household use, the latter containing an excess of chlorine gas by virtue of which it is useful as a disinfectant.

Electrolysis is a third form of internal boiler corrosion. An electric battery might be made up of almost any two elements or metals we could separate in an acid or alkaline bath of electrolyte. Theoretically such is certainly the case, and the amount and potential of the current obtainable would vary with each different combination of metals, some elements being strongly "electro-positive" and some strongly "electro-negative." The commercial battery, with its zinc and carbon elements and its sal ammoniac electrolyte, gives a high output for a low first cost and maintenance, and as such has established its usefulness. With its brass and copper fittings and connections, steel shell and tubes, and slightly acid or slightly alkaline water for electrolyte, a marine boiler may be regarded as a great electric cell, the iron and steel forming the negative electrodes, and the brass and iron the positive. The degree of electric activity—the output, as it were—depends chiefly upon the strength of acidity or alkalinity in the water. For every ampere of current thus developed, a fixed amount of the positive electrode—the iron—is eaten away, just as the zinc sticks are consumed in a common electric bell battery. How far the corrosive effects of magnesium chloride and the carbonic acid-oxygen combination contribute to hasten electrolysis, and how far electrolytic action promotes "rusting," have never been and probably never will be determined. Undoubtedly there are complex inter-relations and reactions of which we realize little, which, if better understood, might help to explain the extraordinary individual phenomena of pitting, grooving, honeycombing and other distinct forms of corrosion, but, in the present state of our knowledge, we can only classify these

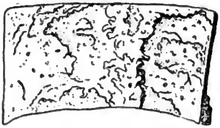


FIG. 1.

FIG. 2.

as various manifestations of the same general causes, producing different results from reasons unknown. Figure 1 is a typical case of electrolytic corrosion of a plate cut from an old main discharge pipe on a P. & O. steamer.

"Cold iron" corrosion, so called, is a familiar cause of deterioration in laid-up boilers. The remedy for this is to remove any one of the three essential accompaniments of rust, carbonic acid, oxygen or moisture. The boiler may be emptied and thoroughly dried, or may be filled up completely and low fires maintained long enough to expel all air from the water, after which all connections should be closed tightly. It is *partial* filling that is responsible for cold iron corrosion.

One is hardly justified in explaining at length the ultimate effects of corrosion of plates, tubes, stays, braces, furnaces and pipes. If corrosion has advanced far enough to weaken any part, the possible damage is limited only by the complete destruction of the vessel by explosion and the death of all on board. The most terrible phase of the subject is that all too often corrosion proceeds to the danger point in out-of-the-way corners, unseen and undetected by even the most vigilant inspection. With the ever-increasing pressures now carried in marine boilers, the necessity, always great, for adopting every possible measure to guard against corrosion is doubly urgent.

"Grooving" is a peculiar form of boiler corrosion, usually occurring near seams or at bends and knuckles. The plate becomes deeply grooved or scored, probably as a result of surface cracks, undue calking of the seams, of expansion and contraction strains, all exaggerated by acid corrosion.

A form of corrosion know as "honeycombing" is illustrated by Fig. 2—part of a plate cut from an exploded boiler. The plate was originally ½ inch thick, but was corroded to a depth of ⅜ inch, the holes appearing as if drilled.

Pitting, unlike general corrosion, is marked by sharply defined edges, resulting in holes and patches of from ¼ inch to 6 inches or more in diameter, the depth of the pit varying

FIG. 3.

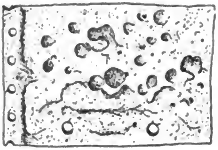


FIG. 4

from 1/32 to ¼ inch or more. Such pitting is shown in the case of a tube in Fig. 3, and of a plate in Fig. 4.

Many and various have been the attempts to devise a cure for corrosion, but in nearly every instance such curative means have followed the plan not unlike the dentist's method of scraping out the decayed area of a bad tooth and filling the cavity. This plan is but a makeshift for a boiler, and the various cements and compounds applied to pits and corroded areas are but temporary reliefs in the *discovered* spots, and afford absolutely no protection against corrosion in other places. Neutralizing the acidity of the feed water will help considerably, but it has too often happened that the chemicals used to this end, and particularly the nostrums sold by boiler compound makers as removers of scale and grease, have wrought a havoc of their own on the plates and tubes far worse than the natural enemies they sought to repel. Zinc in slabs is extensively used in the effort to divert the electrolytic action from the iron to the more electro-positive zinc, and while much good has been accomplished by this method, it is but an incomplete remedy and a very expensive one.

The only complete remedy for corrosion is to coat the interior of the boiler with a strongly adhesive, elastic, continuous layer of non-corrodible material. This must be very thin so as not to interfere with the transmission of heat, and of high conductivity, and it should be *metallic* in nature in order to become part and parcel of the surface of the iron it is supposed to protect. This conclusion is the result of observation of successful results of a boiler compound in which mercurial salts enter into composition, the action of which, when subjected to high heat in a boiler under steam, is to deposit a dark lustrous enamel-like coating over the entire wetted surface of the boiler and its tubes. That the composition as introduced with the feed water contains the necessary corrective elements to neutralize acidity and precipitate the harmful elements of the feed water is to be assumed as a matter of course, leaving the amalgam coating to envelop the exposed surfaces and areas and prevent corrosion.

It is, of course, evident that the writer has in mind a

definite product—the composition of the Bird-Archer Company, of New York. The only living ex-president of the United States, who has immortalized some famous phrases, not long ago said in effect that a successful political party should be one for the "enunciation of principles, not the denunciation of conditions." And so it should be in all things. It is well that we should understand causes and effects, but of greater importance even that we should understand remedies, if there be any. GEORGE P. HUTCHINS.

A Motor Boat Speed Indicator.

The Nicholson Ship Log Company, Cleveland, Ohio, has recently put on the market a motor boat speed indicator. This instrument is designed to show the speed at the moment, through the water, of motor boats and yachts. The principle of operating this instrument is the same as used for the well-known Nicholson log. The sea connection is a 3/8-inch brass pipe, projecting through a 3/4-inch sea cock, about

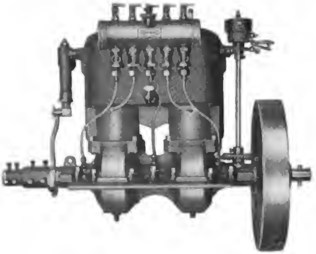
1/2 inch through the shell of the boat. This pipe acts as a scoop which forces the water into a float pipe, causing the float to rise and operate the instrument, a hand on the dial pointing to the speed the boat is making. It is an instrument that will interest all owners of motor boats, sailing yachts and small steam yachts. It can be placed in the cockpit or cabin of any motor boat or yacht.

Kowalsky Two-Cycle Gasoline Engines.

In order to gain its present footing as a motive power for marine craft, the gasoline engine has necessarily undergone many changes and improvements. Simplicity of construction and operation; economy; reliability, great power for size and weight; all these have been demanded by buyers, and have been realized by the different makers in varying degrees. The Kowalsky Engine Company, of Detroit, Mich., has met success during the past season, and the results of the Pittsburg Launch Club races on Aug. 3 made an excellent showing. On that occasion, with a large number of entries, two out of six events were won by boats containing these engines, and a third victory was apparently certain until the leading launch—Kowalsky driven—was run into by another boat and capsized.

Their 1908 model, a cut of which we show, is distinctive in many respects; the cylinder, cylinder head and water jacket are cast in one piece, thus avoiding that leakage of circulating water into the cylinder, which is so often a source of trouble. Another interesting feature is the rotary timer and secondary distributor, by means of which one coil may be used for both cylinders, thus insuring regular timing of the explosions. A slight change in the wiring, however, allows the use of a separate coil for each cylinder if desired.

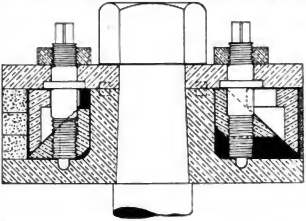
Simplicity of construction and operation, together with maximum power, is secured through the two-cycle design, while



every helpful feature has been adopted to insure long life and reliable, economical operation. Some of these are the long bearings, hardened pins, drop-forged crank shaft, bronze connecting rods, throttling governor, automatic lubrication, jump spark ignition, and so on. Perhaps the most desirable point about the whole equipment as compared with some others is that the engine and propeller run equally well in both directions, and may be reversed while running.

The Economy Piston.

The water end of any steam pump as manufactured to-day is an expensive article for the purchaser; the piston has been left in its primitive state for many logical reasons that are entirely conclusive to the satisfaction of the pump and packing



manufacturers, but this for the user means continued loss and expense. The pump manufacturer claims that no improvement is necessary, as the pumps are easily sold, regardless of any saving or advantages to the purchaser; the packing manufacturer obviously does not favor any improved form of piston that will save the packing and materially lessen his sales.

This piston, made by the Economy Piston Company, 268 Midland avenue, Montclair, N. J., is shown in the left side of the illustration, packed and in normal condition ready for

insertion in the pump cylinder, all parts being contracted smaller than required in order that the piston may be easily placed. When the packing wears, it is forced out against the walls of the cylinder, the piston becoming as tightly packed as desired, and this may be continued until the expansion parts are expanded to the limit, and the packing worn to almost nothing, as shown in the right half of the figure.

This is done by simply removing the cylinder head, loosening the nuts on the collar bolts, and screwing the collar bolts right-handed. The conic segments travel away from the piston body, thus forcing out the cup segments, which in turn force out the bull ring and packing. When adjusted to tightness, the lock nut is tightened and packing is held in expanded position, thereby performing the office of new packing, which may be continued as often as desired until all of it has disappeared.

Drop-Forged Planer Clamps.

A stiff, substantial drop-forged clamp or clamping head for use on planer, lathe, drill press or milling machine, has been developed by J. H. Williams & Company, Brooklyn, N. Y. Made from a strong, tough grade of carefully selected steel and submitted to a special process after forging, increases their strength and stiffness. These forgings, time-saving and

effective, will make possible an assorted, handy lot of clamping devices as commercially available as a machine bolt, and should prove valuable additions to all machine shop equipments. They are made in lengths of 4, 6 and 8 inches, with widths from 1 3/16 to 2⅛ inches, and a maximum thickness of 1⅛ inches. The slots are 1⅜ to 2 13/16 inches long, and 11/16 to 13/16 inch wide.

A Unique Electric Generating Plant.

The illustration shows a novel portable dynamo house with direct-connected electric generating set. The outfit is constructed to carry 10, 20 or 30 lights, according to the candlepower and voltage. When operating at a speed of 850 revolutions per minute, the engine develops 1½ horsepower, and the dynamo supplies a current of 104 volts pressure. The electric generator has a capacity of 7.5 amperes normal load, and will carry a maximum load of considerably above this amount. The equipment is arranged to operate with illuminating gas or natural gas, and also has the carbureter arranged to use alcohol or gasoline (petrol) as a fuel, as well as oil, the heated air entering the carbureter from an open T at the ends, this fitting being slid over the exhaust pipe, and the air entering the T being warmed before reaching the carbureter, by coming in contact with the exhaust pipe, thereby more easily vaporizing the alcohol or oil fuel.

For constant load, with a definite number of lights, no regulator is necessary, the outfit running with practically constant speed, and an extra flywheel and a flexible coupling taking up the impulses of the engine very satisfactorily. For a variable load, the portable house is provided on the left hand side with 50 cells of storage battery of 8 or 10 ampere-hour capacity, this being sufficient to give good regulation and supply a reserve current for night lamps in homes or for extra current during heavy load; taking up current when the set is operating at less than full load. The voltage is held practically constant by the battery floating on the line, 26 cells only being necessary when 52-volt lamps are used, and the engine and dynamo set is run at a correspondingly lower speed, having, of course, at this lower speed a correspondingly lower kilowatt capacity.

For boat lighting this set is satisfactory, as well as for charging automobile batteries, a double cylinder engine of larger capacity with a larger generator in this case being desirable. For store lighting, where a constant number of

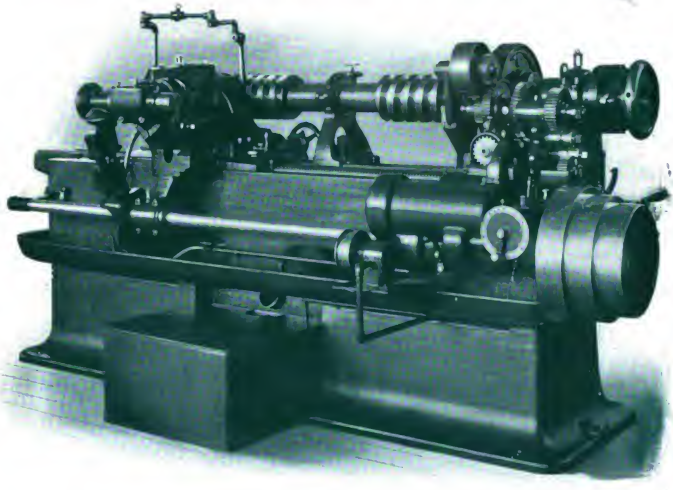
lights are required continuously, a very satisfactory result is obtained without a governor of any kind. But for a variable load the storage battery plant is necessary, to take up the inequalities due to the increased speed when lamps are turned off. With the battery in parallel with the engine-generator set and lighting circuit, the load and speed are held constant on the gasoline motor, even though the number of lights is varied.

The portable house is necessary where the fire underwriters object to gasoline being used as a fuel in buildings insured, but where gas is employed, a plant of this character can readily be employed in a basement of any kind. Similar outfits are in extended use in Germany and England, and without doubt will be largely used in this country. The foreign sets are, however, far more costly, and are all equipped with governors and cast iron bases common to both engine and dynamo.

Where a greater output is necessary, two 1½-horsepower cylinders are mounted together, giving a total of 3 horsepower, with a very even turning moment there being two explosions for each revolution of the dynamo. In this case twenty 16-candlepower lamps may be operated. At this output the muffler entirely deadens the explosions, as in the most quiet running automobiles. For larger kilowatt capacity for charging electric automobiles, and similar service, two 3-horsepower cylinders are used, with a generator of 2½ kilowatts, capable of operating over 40 incandescent lamps. These outfits are designed for portable or stationary service, and are supplied by the Buffalo Mechanical & Electrical Laboratory, Erie County Bank building, Buffalo, N. Y.

THREAD MILLERS

BUILT IN SIX SIZES, WILL MILL FROM A STRAIGHT LINE TO A CIRCLE



This machine is designed for the manufacture of large worms and spiral gears, and is far superior to the engine lathe in accuracy, finish of work and economy of operation.

Write for Catalogue "Thread Milling Machines."

PRATT & WHITNEY COMPANY

HARTFORD, CONN., U. S. A.

OFFICES—Trinity Building, 111 Broadway, New York. Boston: Oliver Building. Chicago: Commercial National Bank Building. Pittsburg, Frick Building. St. Louis: 516 North 3d Street. Philadelphia: 21st and Callowhill Streets. Birmingham, Ala. Brown-Marx Building.
AGENTS—The Canadian Fairbanks Co., Ltd., Montreal, Toronto, Winnipeg and Vancouver.

AGENTS:

BUCK & HICKMAN, Ltd., 2 and 4 Whitechapel Road, London, E. C. Niles-Bement-Pond Co., 23-25 Victoria Street, London, S. W. Copenhagen, Denmark: V. Lowener. Stockholm, Sweden: Aktiebolaget, V. Lowener. Paris, Fenwick Freres & Co., 8 Rue de Rocroy, Agents for France, Belgium, Switzerland. Japan: F. W. Horne, 70-C, Yokohama. Berlin: Ludw. Loewe, Hutten Strasse, 17-20.


BIRD-ARCHER'S
MARINE METALLIC
BOILER COMPOUND